U.S. Army Center for Health Promotion and Preventive Medicine

EPIDEMIOLOGICAL REPORT NO. 12-HF-05SR-05
INJURIES AND PHYSICAL FITNESS BEFORE AND AFTER DEPLOYMENTS
OF THE 10TH MOUNTAIN DIVISION TO AFGHANISTAN
AND THE 1ST CAVALRY DIVISION TO IRAQ
SEPTEMBER 2005 – OCTOBER 2008

U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, MD

US Army Research Institute of Environmental Medicine
Natick, MA

10th Mountain Division
Ft Polk, LA

US Army 1st Cavalry Division
Ft Hood, TX

Injury Study 40-38a

Readiness Thru Health

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Joseph J Knapik, Anita Spiess, Tyson L Grier, Mark E Lester, Marilyn A Sharp, Steven K Tobler, David I Swedler, Bruce H Jones

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14. ABSTRACT

This project examined injuries and physical fitness before and after deployments of the 10th Mountain Division to Afghanistan (10thMt cohort, n=505 men) and 1st Cavalry Division to Iraq (1stCav cohort, n=3242 men). Deployed Soldiers' outpatient medical encounters were obtained from the Armed Forces Health Surveillance Center and examined for injuries during two consecutive 90-day periods before (Periods 1–2) and two consecutive 90-day periods after deployment (Periods 3–4). Army Physical Fitness Test (APFT) data were obtained from testing 4–6 months before and after deployment. Both deployed groups showed postdeployment increases in injury incidence (10thMt=14.1%, 14.1%, 16.4%, 23.4%; 1stCav=15.1%, 12.4%, 35.4%, 43.4%; Periods 1–4, respectively). Limited APFT data (n=178, 10thMt; n=90, 1stCav) indicated that average postdeployment body weights were higher (3–9 lb), but there was generally little difference in the pre- and postdeployment push-up and sit-up scores. The 10thMt group had similar pre- and postdeployment 2-mile run times, but the 1stCav demonstrated an average 5% slower postdeployment run time. This project documented a postdeployment increase in injuries. Further, in some cases, physical fitness may not return to predeployment levels even 4 to 6 months postdeployment, although an appropriate physical training program may ameliorate this effect.

15. SUBJECT TERMS

Army Physical Fitness Test; age, height, weight, body mass index, overuse, ICD-9, prior injury

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DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

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EXECUTIVE SUMMARY
TECHNICAL REPORT NUMBER 12-HF-05SR-05
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1. INTRODUCTION AND PURPOSE. In a letter to the Army Surgeon General, the Chair of the Military Training Task Force (MTTF), Department of the Army, expressed concern about an apparent increase in injury rates among Soldiers returning from deployments. The MTTF Chair requested assistance in determining if such an injury rate occurred consistently among redeployed troops. In response to this request, the current project examined outpatient injury visits and physical fitness before and after deployments of a battalion of the 10th Mountain Division to Afghanistan (10thMt cohort) and a brigade of the 1st Cavalry Division to Iraq (1stCav cohort).

2. METHODS.

a. A list of deployed personnel was provided by the Personnel Offices (S1) of the units shortly after they returned from their deployments. For the 10thMt cohort, this included only the four rifle companies (no headquarters personnel). For the 1stCav cohort, the list included all personnel (combat and support) who deployed with the unit. Medical data of the deployed personnel were requested from the Armed Forces Health Surveillance Center (AFHSC) for two consecutive 90-day periods just before the deployment (Periods 1 and 2) and two consecutive 90-day periods just after deployment, on return to the United States (Periods 3 and 4). The AFHSC returned visit dates and ICD-9 codes for all outpatient medical visits within the four time periods. An injury case was identified if a Soldier had any of a specific set of codes from the International Classification of Diseases, Revision 9, Clinical Modification. Cumulative injury incidences were compared across the four periods.

b. Semiannual Army Physical Fitness Test (APFT) data (including heights and weights) were provided by the units. Data were obtained for tests taken by Soldiers about 4 to 6 months prior to deployment and about 5 to 6 months after deployment. The APFT consisted of three events: the maximum number of push-ups completed in 2 minutes, the maximum number of sit-ups completed in 2 minutes, and a 2-mile run for time. Pre- and postdeployment raw scores were compared using the paired t-test.

3. RESULTS.

a. The 10thMt cohort (n=505), 1stCav male cohort (n=3242) and 1stCav female cohort (n=254) showed postdeployment increases in injury incidence. For the 10thMt cohort, overall injury incidences were 14.1%, 14.1%, 16.4%, and 23.4% for periods 1 to 4, respectively. For the 1stCav male cohort, overall injury incidences were 15.1%, 12.4%, 35.4%, and 43.4%for periods 1 to 4, respectively. For the 1stCav female cohort, injury incidences were 18.9%, 19.3%, 36.2%, and 42.1%for periods 1 to 4, respectively. In both cohorts, those who experienced injuries in the predeployment period were more likely to experience them in the postdeployment period.

b. The units provided matched pre- and postdeployment APFTs for 35% of the 10thMt cohort (n=178), 3% of the 1stCav male cohort (n=84), and 2% of the 1stCav female group (n=6). For the 10thMt group, postdeployment body weight averaged 3 pounds higher than predeployment weight (2%). The APFT raw scores showed very small pre-post differences, and the mean total APFT points were identical (250) in the pre- and postdeployment periods. For the 1stCav men, average body weight was 9 pounds higher (5%) in the postdeployment period. The pre- and postdeployment push-up and sit-up scores differed little. Postdeployment run times averaged 0.7 minutes slower (5%) and APFT scores were 6 points less (3%) compared with the predeployment period. The 1stCav women averaged 7 more pounds in body weight (5%) in the postdeployment period. Female Soldiers averaged 5 fewer postdeployment push-ups (15%); sit-ups changed little, and run times averaged 1.5 minutes slower (8%). Women averaged 13 fewer APFT points in the postdeployment period (6%).

4. DISCUSSION.

a. Both the 10thMt and 1stCav cohorts exhibited a postdeployment increase in the cumulative injury incidence compared with that from predeployment, although the pattern and magnitude of the increase differed in the two cohorts. Intrinsic (personal) factors that may have contributed to the increase in postdeployment injury have been speculated upon in the literature and may include (1) psychological stress due to posttraumatic stress syndrome or depression, (2) adoption of unhealthy coping behaviors like alcohol and drug abuse, (3) ill-defined diseases and syndromes acquired in theater that might affect factors such as decision making, balance, navigation, and reaction time, (4) comorbidities associated with injuries experienced in theater, or (5) increased postdeployment risk taking. Extrinsic (external) factors might include the in-garrison pre- versus postdeployment operational tempo, military training activities, physical training activities, deployment location, activities in theater, length of deployment, hazardous exposures in theater, and environmental conditions.

b. Although both groups had higher postdeployment injury incidence, the pattern and magnitude of the increase differed in the 10thMt and 1stCav cohorts. The 10thMt showed little immediate postdeployment rise in injury incidence (Period 3), but a larger increase later (Period 4). The absolute increase in injury incidence in the 10thMt group was generally less than

half that in the 1stCav cohort. The 1stCav cohort showed a much larger immediate postdeployment increase, with a further elevation in the second postdeployment period. The lower overall postdeployment injury incidence in the 10thMt cohort could be due to the time of year when the first postdeployment period occurred (December-March), the differences in the occupational tasks of the Soldiers, or the physical training program the unit was using. The 10thMt group was using the new Physical Readiness Training Program (PRT) designed to reduce injuries and increase performance on occupational military tasks.

c. For physical fitness, both groups of men generally showed little difference in pre- versus postdeployment muscular endurance (push-up and sit-up performance), but both showed a small gain in body weight. Women (1stCav) demonstrated the weight gain and performed fewer push-ups postdeployment. Aerobic fitness (2-mile run times) results differed in the two cohorts: the 10thMt group showed no difference in pre- versus postdeployment performance while the 1stCav cohort showed a decline in aerobic performance. A previous study that examined a subsample of the 10thMt cohort (n=110) showed that VO_2max during treadmill running was about 5% lower about 18 days postdeployment compared with predeployment. The similar pre- and postdeployment 2-mile run times in the present investigation suggests that the immediate postdeployment loss of aerobic fitness was regained in less than 6 months following return from deployment. A subsample of the 1stCav cohort (n=34) was also administered a 2-mile run 7 to 11 days post-deployment and run times were 13% slower postdeployment. The 5% slower run times reported here suggest that about 5 months postdeployment Soldiers had regained much but not all of their aerobic fitness. While it is known that the 10thMt group was using PRT, the physical training program of the 1stCav was not known.

5. SUMMARY AND CONCLUSIONS. Both groups demonstrated postdeployment increases in injuries, although the pattern and magnitude differed. Within 5 to 6 months postdeployment APFT scores were generally similar to predeployment scores, but the 1stCav group still showed some decrement in 2-mile run time. APFT data were limited and should be viewed with caution. Both intrinsic (personal) and extrinsic (external) factors discussed above are likely to influence injury rates. The present investigation cannot determine the factors that were associated with the elevated postdeployment injury incidence. Nonetheless, the data here indicate that outpatient injury incidence is elevated postdeployment and that, in some circumstances, aerobic fitness may not be fully restored 6 months postdeployment.

6. RECOMMENDATION. Efforts should be focused on determining the activities that are associated with postdeployment injuries so that preventive strategies can be developed. Once these strategies are determined, they should be tested for effectiveness in the postdeployment training environment.

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1. REFERENCES. Appendix A contains the references used in this report.

2. INTRODUCTION AND PURPOSE.

a. In response to the terrorists' attacks on the United States (US) World Trade Center on September 11, 2001, Operation Enduring Freedom (OEF) was launched on 7 October 2001. The initial military objectives of OEF included the destruction of terrorist training camps and infrastructure within Afghanistan, preventing the use of Afghanistan as a safe haven for terrorists, the capture of al Qaeda leaders, and the cessation of terrorist activities in Afghanistan. Military force was directed against the Taliban because they had allowed Afghanistan to be used as a training ground for terrorists and because they refused negotiation. Operations began with air strikes on Taliban and al Qaeda targets. American, British, and other coalition ground troops worked with the Northern Alliance (a loose coalition of indigenous forces opposed to the Taliban) to coordinate air and ground attacks primarily against the Taliban military. Kabul fell on 13 November 2001 and the Taliban retreated from most of northern Afghanistan into the mountainous eastern border region between Afghanistan and Pakistan. From 2002 to 2005, the Taliban and al Qaeda focused on survival and rebuilding their forces. In March 2006, the main body of the 2nd Battalion, 4th Infantry Regiment (2/4th) of the 4th Brigade of the 10th Mountain Division deployed to eastern Afghanistan. They conducted combat operations in support of Combined Forces Command, Afghanistan, and the International Security Assistance Force.

b. About 1.5 years after the terrorists' attacks on the World Trade Center, the Second Gulf War began. On 20 March 2003, Iraq was invaded by a multinational coalition composed of United States (US) and United Kingdom troops supported by smaller armed forces from Australia, Denmark, Poland, and other nations. US officials asserted that Iraq's possession and pursuit of weapons of mass destruction posed a serious and imminent threat to US national security, although assessments by United Nations weapons inspectors and later by US-lead teams in Iraq found no evidence for this. The invasion resulted in the fall of Baghdad and the defeat of the Iraqi military on 9 April 2003, just 20 days after the start of the invasion. The US-led coalition occupied Iraq and attempted to establish a new democratic government. By 16 July 2003, military officials acknowledged that a classic guerrilla warfare insurgency was in progress in Iraq. Guerrilla violence directed against coalition forces was complicated by strife between many Sunni and Shia religious groups. The insurgency and religious violence escalated through 2006.

c. Beginning in late October 2006, elements of the 1st Cavalry Division deployed to Iraq. In mid-November, the 1st Cavalry assumed responsibility for the Multi-National Division when authority was transferred to them at Camp Liberty in Baghdad, Iraq. The division participated in the early part of the build-up of forces in Iraq called "the surge," first announced by President George W. Bush on 10 January 2007. In September 2007, Major General David Petraus (Commanding General of the Multi-National Force-Iraq) stated that violence in Iraq had been reduced significantly. The reasons he proposed included the deployment of forces in counterinsurgency operations designed to protect Iraqi civilians, improving capabilities and ongoing expansion of the Iraqi Army and police forces, significant losses inflicted on Al Qaeda in Iraq and other insurgent groups, the "Anbar Awakening" in which Sunni leaders rejected insurgent leadership and formed the Sons of Iraq groups to defend themselves, sectarian homogenization, and barriers constructed between Baghdad neighborhoods. Efforts by the 1st Cavalry and other forces occupying the region resulted in an approximate 75% reduction in bomb attacks. Patrolling of streets, coupled with early identification and detection of explosive devices, was credited with the reduction in much of the violence.

d. The purpose of the investigation described in this report was to compare the pre- versus postdeployment injuries and physical fitness of Soldiers of the 10th Mountain Division who deployed to Afghanistan and Soldiers of the 1st Cavalry Division who deployed to Iraq. This was in partial fulfillment of a request by the Chair of the Military Training Task Force, Department of the Army, because of anecdotal reports of an increase in injuries among Soldiers after they returned from deployments.

3. AUTHORITY. Under Army Regulation 40-5,[1] the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) is responsible for providing epidemiological consultation services upon request. This project was initiated at the request of the Deputy Director of Training, Office of the Deputy Chief of Staff (G3/5/7), Department of the Army. The Deputy Director of Training made this request in his capacity as the Chair of the Military Training Task Force (MTTF), one of nine task forces of the Defense Safety Oversight Council (DSOC). The request letter appears in Appendix B. Employing the criteria of the Council of the State and Territorial Epidemiologists,[2] it was determined that this project constituted public health practice.

4. BACKGROUND LITERATURE REVIEW. A great number of studies have examined in-theater injuries among military units deployed to various combat areas.[3-17] The literature review in this report, however, focuses on pre- and postdeployment injuries of service. No studies on postdeployment outpatient injuries were found, but the literature contains a number of investigations on postdeployment hospitalization,[18-30] mortality,[31-52] and self-reported injury.[49, 53-55]

a. Hospitalization Studies. Hospitalization studies have both advantages and limitations. On the positive side, the electronic databases currently available allow access to a large number of subjects so that high statistical power can be achieved. Matching inpatient data on these individuals with variables in other databases allows covariates to be examined and controlled, if necessary. The inpatient data of active duty military personal are likely to be fairly complete because (1) these individuals are seldom hospitalized outside of Department of Defense (DoD) facilities where the data are collected and (2) hospitalization is readily available to active duty military personnel. Periodic physical fitness testing may encourage military personnel to seek medical care if they fear the testing will exacerbate problems. Hospitalization studies also have some disadvantages. They collect data only on severe morbidity, that requiring evaluation by health care providers and the determination that the patient must be under close observation and/or control for some period. In addition, some data may be missed: once an individual leaves active duty, they can no longer be tracked in DoD databases, so that conditions that require more time to clinically manifest will not be documented. Results are also influenced by nosology. Who does the coding, what experience they have, and the guidance they receive all influence the accuracy of the diagnosis recorded. Coding is frequently influenced by the cost-related guidance (i.e., regarding reimbursement) given to the nosologist, although this is probably a minor problem in military hospitals where diagnoses are less influenced by insurance claims.[25, 56-58]

(1) Postwar Hospitalization of World War II and Korean War Veterans. Beebe[18] provided data allowing a comparison of the overall postwar hospitalization experience of WWII veterans and Korean War veterans. The follow-up period was 1946 to 1966 (20 years) for WWII Soldiers and 1954 to 1966 (12 years) for Korean War Soldiers. Hospitalization experience was obtained from Army files, from Veterans Administration files, and from a questionnaire mailed in 1967. Table 1 shows comparative hospitalization rates. Admission rates were uniformly higher for Pacific and Korean War service members compared with European War veterans. The magnitude of the difference decreases over time. No specific data were reported on injury hospitalizations.

Table 1. Hospitalization Rates for World War II and Korean Service Members (data from reference [18])

Theatre/War	Hospitalization Rates (admissions/1,000 person-years)				
	4 years postconflict	5–8 years postconflict	9–12 years postconflict	13–16 years postconflict	16–20 years postconflict
European War	17.0	8.9	6.3	6.3	9.0
Pacific War	23.1	12.7	12.3	8.1	10.4
Korean War	35.8	11.1	14.5		

(2) Postdeployment Hospitalization of Vietnam War and First Gulf War Marines. One study[20] compared the 5-year postdeployment hospitalization rates of male enlisted Marines serving in the Vietnam War (n=11,894) and the First Gulf War (n=10,878). The overall age-adjusted hospitalization rate was lower for Marines serving in the First Gulf War than for those who served in Vietnam (0.206 versus 0.272 hospitalizations/1000 person-days, $p<0.01$). The Marines serving in Vietnam had more hospitalizations for infectious/parasitic diseases and genitourinary problems, while the Marines in the First Gulf War had more hospitalizations for musculoskeletal problems. The highest number of hospitalizations for the Vietnam Marines were for "multiple categories" (18%), followed by injury (15%). For the First Gulf War Marines, injury (12%) was the third highest category of hospitalizations, after musculoskeletal conditions (21%) and "multiple categories" (20%). Table 2 compares the proportion of musculoskeletal conditions accounted for by various injury diagnoses in the two cohorts.

Table 2. Comparison of Marines Who Served in Vietnam and First Gulf War on Proportion of Musculoskeletal Disorders Accounted for by Specific Injury Categories (from reference [20])

Type of Injury	Vietnam Marines (% of all musculoskeletal disorders) (n=11,894)	First Persian Gulf Marines (% of all musculoskeletal disorders) (n=10,878)
Internal Derangement of Knee	25	30
Synovium, Tendon, and Bursa	12	16
Other Derangement of Joint	15	14
Intervertebral Disc Disorder	10	not specified in article
Total Accounted for	62	60

(3) Hospitalization of Deployed and Nondeployed Military, Bosnia and First Gulf War.

(a) During peacekeeping operations in Bosnia-Herzegovina and during the First Gulf War, overall prewar hospitalization rates were lower for those who deployed compared with those who did not deploy.[22, 24, 28, 59] In studies of First Gulf War–era service members, the lower hospitalization risk of deployed service members was generally confined to the 3-year period before deployment; there was little difference in hospitalization risk before this 3-year pre-deployment period.[24, 59] Despite the lower overall hospitalization rate of deployed service members, predeployment *injury* hospitalizations were generally higher among the deployed compared with the nondeployed, especially in the 2 years prior to deployment.[59] Post-war comparisons of active duty deployed and nondeployed service members (1–3 year follow-up) showed little difference in hospitalizations for various musculoskeletal system diseases or injuries and poisonings.[24] However, when National Guard and Reserve service members were included in the analysis (9-year follow-up), veterans of the First Gulf War experienced proportionally more postdeployment hospitalizations in the injury and poisoning category,

especially for fractures and for bone and soft-tissue injuries, in two of three databases analyzed.[26]

(b) These studies suggest that the health of the deployed force is better than that of the nondeployed force. The medical screening performed prior to deployment may in part be responsible, since it is designed to identify service members with conditions that might interfere with deployment-related activities.[22] Predeployment injury hospitalizations may be higher among the deployed force (1) because of greater risk-taking behavior[59] or (2) because service members who will deploy are performing more predeployment training than less healthy service members who will not deploy and are thus exposed to more physical hazards.

(4) Hospitalization of Deployed Service Members, Bosnia and Iraq or Afghanistan.

(a) Deployed service members hospitalized prior to deployment were more likely to also be hospitalized during[21-23, 25] or after[19, 22-24, 27] deployment. Recency of hospitalization prior to deployment influences risk of hospitalization during deployment as shown in Table 3. The closer the hospitalization was to deployment, the higher the risk of hospitalization during deployment. Interestingly, those hospitalized prior to the First Gulf War were more likely to enroll in the First Gulf War clinical registries, as compared with those not hospitalized prior to deployment.[27, 60-62] This may suggest more health-seeking behavior on the part of registry service members.

Table 3. Relative Risk of Hospitalization During Deployment

Study	Deployment Area	Relative Risk of Hospitalization (prior hospitalization / no prior hospitalization)			
		Never Hospitalized Prior to Deployment	Hospitalized 0–30 Days Prior to Deployment	Hospitalized 31–90 Days Prior to Deployment	Hospitalized 90+ Days Prior to Deployment
Brundage et al.[23]	Bosnia-Herzegovina	1.0	3.8	2.6	1.4
Taubman[21]	Iraq or Afghanistan	1.0	3.0	2.4	1.6

(b) During the Bosnia-Herzegovina peacekeeping operations, when compared with those never hospitalized prior to deployment, postdeployment hospitalization rates for Soldiers with musculoskeletal/injury problems were 1.7 times greater among those who had a predeployment musculoskeletal/injury hospitalization. This was the lowest "recurrence" risk (postdeployment/predeployment) of 11 diagnostic categories, with risk ratios ranging from 1.7 to 17.1.[23] For Iraq-Afghanistan deployments, when compared with those never hospitalized prior to deployment, postdeployment hospitalization rates for musculoskeletal problems and nonbattle injuries were 1.5 and 1.3 times greater, respectively, among those with predeployment hospitalization for the same problem. In this case, musculoskeletal problems and nonbattle injuries were ranked 8th and 13th, respectively, among 16 diagnostic categories.[21] Thus,

although the risk of another musculoskeletal injury hospitalization was higher if a prior hospitalization had occurred, the increase in risk was less than for most other types of diagnoses.

(c) Additional covariates associated with postdeployment hospitalization in First Gulf War service members included in-theater hospitalization, female gender, older age, Army (compared with other services), being married, lower rank, reservist (compared with those on active duty), and combat or health care specialty (relative to electronic equipment repair).[19, 24, 25, 27, 30] War-related exposures such as anthrax/botulism immunizations, exposure to low-level chemical agents, exposure to oil well fires, and theater presence during combat operations were not related to postdeployment hospitalization over short or longer term (up to 10 years) follow-ups.[25, 30] No studies have specifically examined covariates associated with postwar injury hospitalizations.

(d) Over a 10-year follow-up period (1995–2004) of service members who were deployed during the First Gulf War and who remained on active duty, the most common reasons for postdeployment hospitalization (exclusive of pregnancy-related conditions) were musculoskeletal problems (ICD-9 codes 710–739, 33%), digestive system problems (ICD-9 codes 520–579, 24%), and injuries and poisoning (ICD-9 codes 800–999, 21%).[30] This is similar to the overall Department of Defense hospitalizations reported by the Army Medical Surveillance Activity, which are shown in Table 4.[63, 64]

Table 4. Department of Defense–Wide Hospitalizations by ICD-9 Code Groups (From references [63, 64])

ICD-9 Code Groups	1993		1997		2000		2001		2002		2004	
	Cases	Rank	Cases	Rank	Cases	Rank	Cases	Rank	Cases	Rank	Cases	Rank
Musculoskeletal Conditions	29,168	1	12,182	2	7,577	4	5,796	5	6,394	5	6,360	5
Injuries & Poisonings	18,354	4	9,777	4	10,183	3	7.636	3	10,269	3	11,300	2
Mental Disorders	17,824	5	11,651	3	11,331	2	9,095	2	10,659	2	9,309	3
Pregnancy-Related	20,748	3	16,053	1	16,741	1	14,315	1	17,681	1	15,913	1
Digestive Conditions	27,878	2	9,730	5	7,446	5	6,044	4	7,666	4	6,640	4

(5) Postdeployment Hospitalization, First Gulf War, Southwest Asia, and Bosnia. One study[19] compared the post-deployment hospitalization experience of active-duty US military personnel following service in (1) the First Gulf War, (2) Southwest Asia after the First Gulf War, or (3) Bosnia. This study sought to compare hospitalizations among service members sent into conflict zones with different risks. Follow-up times were 10.4 years, 9.4 years, and 5.1 years for First Gulf War veterans, post-war Southwest Asia veterans, and Bosnia veterans, respectively. Postdeployment hospitalizations occurred in 17% of First Gulf War veterans, 11% of postwar Southwest Asia veterans, and 7% of Bosnia veterans. Compared with First Gulf War veterans, those deployed to Southwest Asia after the First Gulf War were at higher risk of musculoskeletal problems (ICD-9 Codes 710–739) and injuries and poisoning (ICD-9 codes

800–999); those deployed to Bosnia were at lower risk of morbidity from these diagnoses. The lower morbidity among Bosnia veterans may be due to the shorter follow-up time; it could also be due to more in-theater hospitalizations,[22, 23] so that service members required less "delayed" postdeployment hospitalization.

(6) Postdeployment Hospitalization on Return from Afghanistan or Iraq. One study[29] examined hospitalizations in serial cohorts of service members who completed deployments to Afghanistan or Iraq between 1 January 2002 and 30 September 2006. Among the 552,101 active duty service members returning from Afghanistan or Iraq, 21,198 incident hospitalizations occurred during the first year after redeployment. The overall rate was therefore 43.8 hospitalizations/1,000 person-years. The highest rates of hospitalizations were for injuries and poisonings; musculoskeletal and connective tissue disorders ranked fourth after injury and poisoning, pregnancy-related conditions, and mental health. Table 5 and Figure 1 show the hospitalization rates in 6-month cohorts. The highest overall rates occurred during calendar year 2003; these were cohorts who deployed during the first phases of Operation Iraqi Freedom and were involved in combat. Excluding pregnancy-related conditions, hospitalization rates in the first 6 months of 2003 for injury and poisoning were 1.3 times higher than for musculoskeletal and connective tissue disorders (second highest category) and 1.4 times higher than for mental disorders (third highest category).

Table 5. Incident Hospitalizations among Redeployed Service Members from Afghanistan and Iraq by Time of Redeployment (from reference [29])

Time of Redeployment	Hospitalization Within 1 Year After Redeployment			
	Injuries and Poisoning		Musculoskeletal and Connective Tissue Disorders	
	Cases (n)	Rate (cases/1,000 person-years)	Cases (n)	Rate (cases/1,000 person-years)
January – June 2002	18	7.2	10	4.0
July – December 2002	50	9.4	29	5.5
January – June 2003	127	11.7	96	8.8
July – December 2003	271	8.6	175	5.6
January – June 2004	653	9.9	385	5.8
July – December 2004	610	9.9	419	6.8
January – June 2005	704	8.6	406	5.0
July – December 2005	502	6.7	366	4.9
January – June 2006	757	7.3	460	4.4
July – December 2006	185	4.1	122	2.7
Overall (January 2002 – December 2006)	3,877	8.0	2,468	5.1

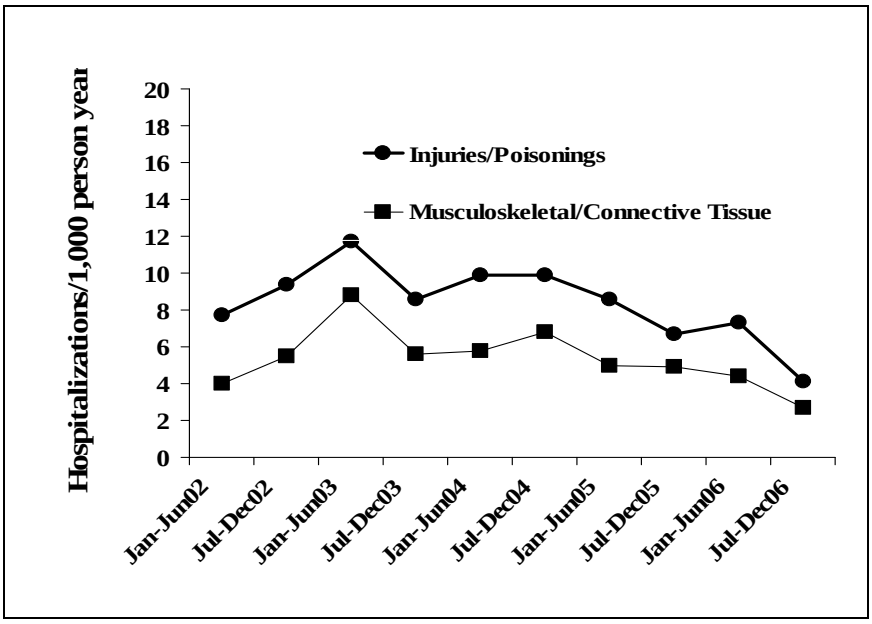

Figure 1. Incident Hospitalizations Within One Year of Redeployment from Afghanistan or Iraq

b. Injury-Related Mortality Studies. A number of studies have examined injury-related mortality among veterans of World War II, the Korean War, the Vietnam War, and the First Gulf War.

(1) World War II and the Korean War.

(a) Few studies[18, 42-44] have been performed on the postwar mortality of WWII or Korean War veterans, despite the large number of service members deployed in these conflicts. This may be because of the difficulty of tracking these veterans after they left service before electronic record keeping was developed. The studies that have been performed compare veterans who fought in the Pacific, European, and Korean theaters and focus on repatriated prisoners of war (POWs). These studies also make comparisons between veterans and the general US population using standardized mortality ratios (SMR).

(b) The POW studies[18, 42, 44] generally show that postwar mortality differed depending on the theater. Pacific War POWs had almost twice the mortality rate of non-POW Pacific War veterans in the first 5 years of follow-up. Over time, this mortality difference declined, so that, by the 10th year of follow-up, mortality was about the same for both groups. (About 90% of the Pacific War POWs were captured April-May 1942 when Bataan and Corregidor fell.) When Korean War POWs were compared with non-POW Korean War veterans, the mortality rate among POWs was about 1.3 times that among non-POW veterans. This difference persisted for

about 13 years and then declined, so that subsequent mortality rates were about the same. European War POWs showed an irregular pattern. Compared with non-POW European War veterans, POWs actually had lower mortality risk in the first 5-year follow-up period and higher risk in the 5–10 year follow-up period.

(c) Keehn[42] provided data on a 30-year follow-up of WWII Soldiers. He also provided sufficient information for a secondary analysis comparing overall mortality among groups of veterans in the WWII Pacific and European theaters. Besides Pacific and European War veterans, two additional groups were analyzed: (1) a group of combat riflemen with at least 65 days of combat exposure who also served in units with combat casualties and (2) general service veterans who were selected from a larger representative group of Army enlisted and officers (the selection criteria was not defined). Thirty-year mortality of the Pacific veterans, European veterans, combat riflemen, and general service veterans were 18.7%, 15.5%, 14.7%, and 17.6%, respectively. Risk ratios comparing the WWII groups are in Table 6 (secondary data analysis). Pacific veterans were at higher risk than other groups.

Table 6. Secondary Analysis of Risk Ratios Comparing Groups of World War II Veterans (Data from [42])

Comparison	Risk Ratios (95%CI)	p-value
Pacific Veterans/European Veterans	1.21 (1.02–1.42)	0.02
Pacific Veterans/Combat Riflemen	1.27 (1.01–1.60)	0.04
Pacific Veterans/General Service Veterans	1.06 (0.93–1.21)	0.36
European Veterans/Combat Riflemen	1.05 (0.81–1.36)	0.69
European Veterans/General Service Veterans	0.88 (0.74–1.04)	0.14
General Service Veterans/Combat Riflemen	1.20 (0.94–1.51)	0.13

Legend: 95%CI= 95% confidence interval

(2) Vietnam

(a) The injury-related results of the Vietnam-era investigations of US and Australian service members are summarized in Table 7. Most investigations showed that injury-related mortality (i.e., from all external causes) was elevated in veterans who served in Vietnam, compared with those that did not. The studies that did not show an excess of injury-related mortality for veterans serving in Vietnam generally involved more select groups of service members and/or smaller samples.[32, 41, 51, 65] With one exception,[31] all studies examining motor vehicle–related mortality showed higher mortality rates among veterans who served in Vietnam. A few studies[31, 39, 65, 66] showed higher rates of suicide-related mortality rates among veterans with Vietnam service, but most[32-35, 38, 40, 50, 51, 67] showed little difference between veterans who had served in Vietnam and those who did not. Most studies examining homicide-related mortality[31, 33-35, 51, 65] suggest a slight excess among veterans with service in Vietnam.

Table 7a. Studies Examining Injury-Related Post-Vietnam Service Mortality (Proportion Mortality Investigations)

Study (Reference No)	Study Characteristics				Mortality Rate Ratios Vietnam Veterans/Non-Vietnam Veterans (95% confidence intervals where available)			
	Follow-Up Period (yr)[a]	Sample	Sample Size	Measure	All Injury	Motor Vehicle Accidents	Suicide	Homicide
Kogan & Clapp 1985[50]	M=10–25	US White ♂ Veterans from MA State	VN=840 NVN=2,515	PMR	1.08	1.10	0.93	0.80
Lawrence 1985 [31]	M=7–10	US ♂ Veterans from NY State	VN=555 NVN=941	APMR[b]	no data in article	0.86 (0.66–1.11)	1.24 (0.88–1.75)	1.59 (0.86–2.94)
Anderson et al. 1986[51]	M=3–14	US White ♂ Veterans from WI State	VN=922 NVN=1,569	PMR	0.99 (0.96–1.03)	1.03 (0.95–1.11)	0.98 (0.84–1.15)	no data in article
Breslin et al. 1988[32]	M=8–17	US Army ♂ Veterans	VN=19,708 NVN=22,904	PMR	1.03 (1.02–1.04)	1.05 (1.01–1.09)	0.93 (0.88–0.98)	1.01 (0.73–1.40)
		US Marine ♂ Veterans	VN=4,527 NVN=3,781		1.00 (0.95–1.05)[c]	1.07 (0.97–1.18)	0.93 (0.86–1.01)	0.98 (0.89–1.08)
Bullman et al. 1990[33]	M=11–19	US Army Veterans	VN=6,668 NVN=27,917	PMR	1.06 (1.03–1.09)	1.08 (1.02–1.14)	0.97 (0.90–1.04)	1.07 (0.99–1.16)
Watanabe et al. 1991[34]	M=10–20	US Army ♂ Veterans	VN=24,145 NVN=27,917	PMR	1.03 (1.01–1.05)	1.03 (0.99–1.07)[c]	0.96 (0.91–1.01)[c]	1.02 (0.98–1.10)[c]
		US Marine ♂ Veterans	VN=5,501 NVN=4,505		1.02 (0.99–1.05)[c]	1.02 (0.95–1.12)[c]	0.99 (0.89–1.10)[c]	1.04 (0.93–1.17)[c]
Visintainer et al. 1995[65]	M=18–24	US ♂ Veterans from MI State	VN=3,364 NVN=5,229	PMR	0.95 (0.89–1.02)	no data in article	1.03 (0.93–1.14)	1.03 (0.93–1.14)
Watanabe & Kang 1996[35]	M=17–23	US Army ♂ Veterans	VN=27,596 NVN=31,757	PMR	1.04	1.03	0.97	1.05 (1.01–1.09)
		US Marine ♂ Veterans	VN=6,237 NVN=5,040		1.02	1.02	1.01	1.01

Legend:
M=Maximal follow-up period
US=United States, MA=Massachusetts, NY=New York, WI=Wisconsin, MI=Michigan
♂=male
VN=Vietnam-era veterans serving in Vietnam
NVN=Vietnam-era veterans not serving in Vietnam
PMR=proportionate mortality ratio
APMR=Adjusted proportionate mortality ratio

Notes:
[a] The first number is the year the last person entered the study to the end of the survey period; the second number is the year the first person entered the study to the end of the survey period
[b] Adjusted for age, race, and education
[c] Approximate confidence interval calculated from data in study

Table 7b. Studies Examining Injury-Related Post-Vietnam Service Mortality (Retrospective Cohort Investigations)

Study (Reference No)	Study Characteristics				Mortality Rate Ratios Vietnam Veterans/Non-Vietnam Veterans (95% Confidence Intervals where available)			
	Follow-Up Period (yr)[a]	Sample	Sample Size	Measure	All Injury	Motor Vehicle Accidents	Suicide	Homicide
Fett et al. 1984 (66)	M=9–16	Australian ♂ Army Conscripts	VN=19,205 NVN=26,957	MRR	1.3 (1.0–1.3)	1.2 (0.9–1.5)	1.5 (0.9–2.3)	no data in article
Boyle et al. 1987(40)	M=12–18 A=14	US Army ♂ Junior Enlisted Veterans	VN=9,324 NVN=8,989	MRR	1.25 (1.00–1.55)	1.48 (1.04–2.09)	0.98 (0.58–1.65)	0.99 (0.57–1.71)
Thomas et al. 1991(38)	M=15–23 A=17	US ♀Service Members	VN=4,582 NVN=5,324	AMRR[b]	1.33 (0.80–2.23)	3.19 (1.03–9.86)	0.96 (0.39–2.39)	no data in article
Watanabe et al. 1995(39)	M=18–24 A=22	US Army Marines	VN=10,716 NVN=9,346	MRR	1.20 (0.99–1.45)	1.04 (0.76–1.43)	1.15 (0.75–1.76)	no data in article
Dalager & Kang 1997(41)	M=18–26 A=20	US Army Chemical Corps Personnel	VN=2,872 NVN=2,737	AMRR[c]	0.83 (0.57–1.22)	no data in article	no data in article	no data in article
Boehmer et al. 2004(67)	M=29–35 A=30	US Army ♂ Junior Enlisted Veterans	VN=9,324 NVN=8,989	MRR	1.19 (1.01–1.39)	1.24 (0.94–1.64)[e]	1.03 (0.74–1.44)[e]	0.90 (0.60–1.36)[e]
Cypel & Kang, 2008(52)	M=32–40	US ♀ Service Members	VN=4,586 NVN=5,325	AMRR[d]	1.34 (0.91–1.96)	2.60 (1.22–5.55)	0.90 (0.44–1.85)	no data in article

Legend:
yr=years
M=Maximal follow-up period ().
A=Average follow-up time (if reported).
US=United States
♂=male
♀=female
VN=Vietnam-era veterans serving in Vietnam
NVN=Vietnam-era veterans not serving in Vietnam
MRR=mortality rate ratio
AMRR=adjusted mortality rate ratio

Notes:
[a] The first number is the year the last person entered the study to the end of the survey period; the second number is the year the first person entered the study to the end of the survey period
[b] Adjusted for age, race, rank, military occupational specialty, and duration of military service
[c] Adjusted for age, race, rank, and duration of military service
[d] Adjusted for rank, marital status, duration of military service, age at entry and race
[e] Calculated from data in article

(b) A small portion of the excess external-cause mortality appears to be due to drug-related events. Two studies[40, 67] involving the same cohort of US Army Soldiers showed an excess of deaths from accidental poisoning (ICD-9 codes E850–E869) over an average 30-year follow-up period (mortality rate ratio (Vietnam veterans/non-Vietnam veterans)=2.26, 95%CI=1.12–4.57). When all-cause mortality was categorized to indicate all drug-related events, the Vietnam veterans experienced an excess of deaths for drug-related reasons over the 30-year follow-up (mortality rate ratio (Vietnam veterans/non-Vietnam veterans)=1.70, 95%CI=1.01–2.86). However, accidental poisonings and drug-related events accounted for only 6% and 2%, respectively, of all external cause deaths.

(c) Interestingly, in the studies of Australian Vietnam service members,[36, 37, 66] adjustment for the service corps (infantry, engineer, armor/artillery, minor field presence, no field presence) considerably reduced the mortality rate ratios. This was primarily because most of the excess mortality occurred among engineers. In Vietnam, Australian engineers were involved in laying, detection, and disposal of mines; tunnel clearance; demolition (field units); civil engineering; water supply; and sewage (construction units); and workshop and park activities. Boyle et al.[40] indicated that the US Vietnam Experience Study did not find higher combat-zone mortality among engineers, but the number of engineers in that study was small (data were not shown in the article).

(d) Two studies (using the same cohort with different follow-up times) examined US female veterans from the Vietnam era.[38, 52] Of the estimated 5,000 to 7,000 US service women who served in Vietnam, most were nurses.[38] When compared with their respective controls, motor vehicle-related mortality appears to be higher among female Vietnam veterans than among male Vietnam veterans.

(3) First Gulf War

(a) Table 8 summarizes the five retrospective cohort studies that examined postconflict injury-related mortality among First Gulf War veterans from the United States, the United Kingdom, and Australia. The two studies of US veterans[45, 46] compared virtually all service members serving in the Gulf War to a stratified random sample of about half of all service members (active duty, National Guard and Reserves) serving outside the Gulf theater during the period of the war. As the table shows, there was an excess of injury-related mortality among First Gulf War veterans compared with non-Gulf War veterans. Motor vehicle-related events accounted for much of this excess mortality. Among US men and the UK and Australian cohorts (which were also predominantly men), deaths from suicide or homicide were generally lower among Gulf War veterans than among non-Gulf War veterans.

Table 8. Studies Examining Injury-Related Post-Persian Gulf Service Mortality (all investigations are retrospective cohort)

Study (Reference No)	Study Characteristics				Mortality Rate Ratios - Gulf Veterans/Non-Gulf Veterans (95% Confidence Intervals)			
	Follow-Up Period (yr)[a]	Sample	Sample Size	Measure	All Injury	Motor Vehicle Accidents	Suicide	Homicide
Kang and Bullman, 1996 (45)	M=3	♂ US Service Members	GV=544,270 NGV=456,726	AMRR[c]	1.17 (1.07–1.29)	1.27 (1.09–1.48)	0.88 (0.72–1.08)	0.80 (0.61–1.05)
		♀ US Service Members	GV=49,919 NGV=84,517		1.78 (1.16–2.73)	1.81 (0.96–3.41)	1.47 (0.63–3.43)	2.66 (0.96–7.36)
Kang and Bullman, 2001 (46)	M=7 A=7	♂ US Service Members	GV=578,369[b] NGV=646,997[b]	AMRR[d]	1.04 (0.99–1.10)	1.19 (1.09–1.30)	0.92 (0.83–1.02)	0.90 (0.78–1.04)
		♀ US Service Members	GV=43,533[b] NGV=99,25[b]		1.39 (1.08–1.80)	1.63 (1.09–2.45)	1.29 (0.78–2.31)	1.54 (0.86–2.76)
MacFarlane et al., 2000(47)	M=8	UK Service Members	GV=53,416 NGV=53,450	MRR	1.18 (0.98–1.42)[f]	1.25 (0.91–1.72)	0.98 (0.65–1.48)	0.75 (0.11–4.44)
MacFarlane et al., 2005(48)	M=13	UK Service Members	GV=51,753 NGV=50,808	AMRR[e]	1.19 (1.02–1.39)	1.44 (1.13–1.84)[g]	1.04 (0.80–1.36)	no data in article
Sim et al., 2002 (49)	M=10	Australian Service Members	GV=1,833 NGV=2,847	AMRR[f]	1.1 (0.5–2.9)	few cases; no data in article	few cases; no data in article	few cases; no data in article

Legend:
yr=years
M=Maximal follow-up period
A=Average follow-up time (if reported).
US=United States
UK=United Kingdom
♂=male
♀=female
GV=Gulf War veterans
NGV=not Gulf War veterans
MRR=mortality rate ratio
AMRR=adjusted mortality rate ratio

Notes:
[a] The first number is the year the last person entered the study to the end of the survey period; the second number is the year the first person entered the study to the end of the survey period.
[b] Estimated from demographics in article.
[c] Adjusted for age, gender, race, branch of service and component
[d] Adjusted for age, race, service branch, component and marital status
[e] Adjusted for age
[f] Adjusted for age, rank, and service type
[g] Called “transportation accidents” using ICD-10

(b) About 50,000 US service women served in the Persian Gulf conflict, making up 7% of the total US force. The two studies of US veterans that specifically examined service women[45, 46] suggest that the post-Gulf War mortality experience of women differed from that of the men. As Table 8 shows, when compared with their male counterparts, female First Gulf War veterans had higher adjusted mortality rate ratios for all external causes, for motor vehicle accidents, and for suicide and homicide.[45, 46]

(4) Temporal Changes in Injury Mortality. Several investigations have found that the excess postconflict injury-related mortality in conflict-zone veterans appears to diminish over time. In the Vietnam Experience Studies,[40, 67] Vietnam veterans showed considerably reduced excess motor vehicle–related mortality after 6–14 years of follow-up and virtually no excess mortality when examining 6–30 years of follow-up, as shown in Table 9. Kang and Bullman[46] examined US First Gulf War veterans and separated motor vehicle accident mortality into four 20-month periods (1.7 years) as shown in Table 8. Similar to the Vietnam cohort,[40, 67] the motor vehicle mortality rate ratio progressively decreased over the 6.7 years of follow-up. Finally, Macfarlane et al.[48] examined temporal changes in all external cause mortality rate ratios of UK Gulf War veterans and found a reduction after 7–13 years of follow-up, as Table 8 shows. One exception to these trends of decreasing rates was a Vietnam Marine cohort[39] that showed similar mortality rate ratios (Vietnam Marines/non-Vietnam Marines) in the first 5 years of follow-up compared with later a follow-up (up to 24 years) for all injuries and motor vehicle-related events. The authors[39] did not report the exact mortality rate ratios in their article.

Table 9. Temporal Changes in Injury-Related Mortality Rate Ratios (95%CIs) in Various Studies

Conflict	Study	Follow-up Period (yr)	Mortality Rate Ratios (Conflict-Zone Veterans/Non-Conflict-Zone Veterans) (95% confidence intervals)			
			All External Causes[b]	Motor Vehicle Events[b]	Suicide (E950–959)[b]	Homicide (E960–969)[b]
Vietnam	Boyle et al., 1987 & Boehmer et al., 2004 [40, 67]	≤5	ND	1.93 (1.16–3.22)	1.72 (0.76–3.88)	1.52 (0.59–3.91)
		6–14	ND	1.16 (0.72–1.87)	0.64 (0.32–1.30)	0.78 (0.39–1.55)
		6–30	ND	1.02 (0.73–1.43)	0.93 (0.64–1.34)	0.80 (0.50–1.26)
Gulf	Kang & Bullman, 2001[46]	≤1.7	ND	1.32 (1.13–1.53)	ND	ND
		1.8–3.3	ND	1.21 (1.01–1.45)	ND	ND
		3.4–5.0	ND	1.17 (0.98–1.40)	ND	ND
		5.1–6.7	ND	1.00 (0.82–1.22)	ND	ND
	MacFarlane et al., 2005[48]	≤6	1.13 (1.06–1.63)	ND	ND	ND
		7–13	1.05 (0.83–1.33)	ND	ND	ND

Legend:
yr=years
ND=No data reported in article

c. Self-Reported Injuries.

(1) Although self-reported injury studies are subject to recall and misclassification bias, they can provide useful data to determine service members' perceptions. Four studies were found that included self-reports of injuries among First Persian Gulf War veterans.

(2) Two studies were performed on self-reported medical problems[53, 54] among First Gulf War–era veterans in Iowa using apparently the same database and similar statistical analyses. Data were obtained by telephone interviews. In one study,[53] the 3-month prevalence of self-reported injuries or impairing injuries was only slightly higher in First Gulf War veterans relative to non–Gulf War veterans (injuries RR =1.07, 95%CI=0.92–1.25; impairing injuries RR =1.06, 95%CI=0.75–1.48; secondary data analysis). In the second study,[54] injuries requiring medical attention were more likely in the First Gulf War veterans, relative to non–Gulf War veterans (OR=1.26, 95%CI=1.02–1.55).

(3) Another two studies obtained data using mailed questionnaires.[49,55] One found that twice as many First Gulf War veterans (n=11,441) as non–Gulf War veterans (n=9,476) reported staying home from work because of an illness or injury in the previous 2 weeks (28% versus 14%). More First Gulf War veterans reported an impairment that limited the type of employment they could take or the kind of work they could do around the house (17% versus 12%). A higher proportion of First Gulf War veterans had visited a medical care provider in the previous year (51% versus 41%). First Gulf War veterans also reported more arthritis (23% versus 17%), lumbago (14% versus 9%), and diseases of the muscles (7% versus 4%). The other study[49] involved a general health questionnaire administered to Australian First Gulf War–era veterans (about a 10-year follow-up). It found no difference between First Gulf War veterans (n=1,419) and non–Gulf veterans (n=1,539) in the self-reported annual prevalence of hospitalization or in the number of days of hospitalization.

5. METHODS FOR THIS INVESTIGATION. This project examined injuries and physical fitness before and after deployments to Afghanistan and Iraq. The unit that deployed to Afghanistan was the 2nd Battalion of the 4th Infantry Regiment (2/4th Infantry), which was part of the 4th Brigade of the 10th Mountain Division garrisoned at Fort Polk, Louisiana. Soldiers examined in this unit are hereafter referred to as the 10thMt cohort. The unit that deployed to Iraq was the entire 4th Brigade of the 1st Cavalry Division (4/1st Cavalry), garrisoned at Fort Bliss, Texas. Soldiers examined in this unit are hereafter referred to as the 1stCav cohort.

a. Project Design.

(1) Medical data (injuries) were obtained for two consecutive 90-day periods just before deployment and two consecutive 90-day periods just after deployment. Period 1 was 185–

95 days before the main body of troops deployed; Period 2 was 94–4 days before the main body of troops deployed; Period 3 was 4–94 days after the main body of troops returned; Period 4 was 95–185 days after the main body of troops had returned. Physical fitness data were from the routine semiannual Army Physical Fitness Test (APFT) given by the units. The APFT just before deployment and the first APFT after deployment were obtained. Table 10 provides the dates of collection for the medical and APFT data.

Table 10. Time Periods for Medical and APFT Data

		Predeployment		Postdeployment	
Data Type	Cohort	Period 1	Period 2	Period 3	Period 4
Medical	10thMt	2SEP05–30NOV05	1DEC05–28FEB06	1DEC06–1MAR07	2MAR07–30MAY07
	1stCav	24APR06–22JUL06	23JUL06–20OCT06	3JAN08–2APR08	3APR08–30JUN08
APFT	10thMt	7SEP05–31OCT05		29JAN07–26JUN07[a]	
	1stCav	13MAR06–18OCT06		20FEB08–30OCT08[b]	

Notes:
[a] 85% of Soldiers took the postdeployment APFT between 30APR07 and 8JUN07
[b] 76% of Soldiers took the postdeployment APFT between 17APR08 and 27JUN08

(2) The Personnel Offices (S1) of the two units provided a list of deployed personnel shortly after they returned from the deployment. The list for the 10thMt cohort included only the Soldiers in the 4 rifle companies making up the battalion (i.e., no headquarters or support personnel). For the 1stCav cohort, all personnel (combat and support) that deployed with the unit were listed.

b. Injury Data.

(1) The Armed Forces Health Surveillance Center (AFHSC) regularly compiles data on ambulatory (outpatient) encounters at military treatment facilities (MTFs), as well as those that occur elsewhere but that are paid for by the DoD. The AFHSC was provided the list of the deployed personnel. AFHSC returned visit dates and ICD-9 codes for all outpatient medical visits within the four time periods listed under "medical data" in Table 10. The first four diagnoses for each visit were considered, although for most visits only a single diagnosis was recorded. An injury case was identified if a Soldier had any of the ICD-9 codes from one of five indices. These indices, which included the Installation Injury Index (III), the Modified Installation Injury Index (MIII), the Training Related Injury Index (TRII), the Overuse Injury Index (OII), and the Comprehensive Injury Index (CII), have been described previously.[68]

(2) The III was developed by personnel at the AFHSC. It has been used to compare overall injury rates (acute and overuse) among military posts and is reported on a monthly basis on the AFHSC website (http://afhsc.army.mil). The MIII, TRII, CII, and OII were developed by personnel in the CHPPM Injury Prevention Program. The MIII captures a greater number of injuries than the III, including more injuries related to cumulative microtrauma (overuse-type injuries). The TRII is limited to lower extremity overuse injuries and was originally designed to

compare injury rates among basic training posts. The OII captures both upper and lower body overuse-type injuries and includes diagnoses such as stress fractures, stress reactions, tendonitis, bursitis, fasciitis, arthralgia, neuropathy, radiculopathy, shin splints, synovitis, and musculoskeletal pain (not otherwise specified). The CII attempts to be comprehensive, capturing all ICD-9 codes related to both acute and overuse-type injuries.

c. Army Physical Fitness Test (APFT) Data. APFT data were provided by the S-3 office (Operations, Plans, and Training) of the 2/4th Infantry (10thMt cohort) and the Executive Officers of the 4/1st Cavalry (1stCav cohort). The 1stCav APFTs were primarily from the 2nd battalion of the 12th Cavalry Regiment, but other Brigade personnel were also included. The APFT consists of three events: the number of push-ups completed in 2 minutes, the number of sit-ups completed in 2 minutes, and a 2-mile run for time. For push-ups, a Soldier was required to lower his or her body in a generally straight line to a point where his or her upper arm was parallel to the ground, and then return to the starting point with elbows fully extended. For sit-ups, the Soldier bent his knees to a 90-degree angle and interlocked fingers behind the head while a second person held the individual's ankles to keep the heels firmly on the ground. The Soldier raised the upper body to a vertical position so that the base of the neck was anterior to the base of the spine and then returned to the starting position. Run performance was measured as the Soldier's time to complete the 2-mile distance. Age- and gender-adjusted points (total score) were given to the Soldier based on the performance level achieved, as described in Army Field Manual 20-21.[69]

d. Physical Characteristics and Demographics. Height and weight were measured during the APFT and these were obtained from the units along with the APFT data. Body mass index (BMI) was calculated as weight/height^2.[70] AFHSC provided demographic information based on data from the Defense Manpower Data Center (DMDC). Demographic data included rank, educational level, marital status, race, and gender.

e. Data Analysis.

(1) Descriptive data were calculated for the APFT scores, physical characteristics, and demographics. For continuous variables, means and standard deviations (SD) were calculated; for ordinal/nominal data, frequencies and proportions were determined.

(2) Cumulative injury incidence for each of the injury indices (III, MII, TRII, OII and CII) was calculated for each of the four 90-day periods as

$$[(\sum \text{Soldiers with} \geq 1 \text{ injury visits}) / (\sum \text{of all Soldiers})] \times 100\%.$$

For each injury index, comparisons of cumulative injury incidence between each of the four periods were determined using the McNemar Test. The McNemar Test allows comparison of frequency data involving repeated measures on the same individuals.[71]

(3) The chi-square statistic was used to make comparisons of postdeployment injury incidence among Soldiers with and without predeployment injuries.

(4) A t-test for related samples was used to make comparisons of Soldiers' pre- and postdeployment height, weight, BMI, and APFT scores. For some between-group comparisons an independent samples t-test was used.

6. RESULTS. The S-1 offices provided a list of 505 male soldiers who had deployed in the 10thMt cohort (one battalion) and 3,496 Soldiers (men=3,242, women=254) who deployed in 1stCav cohort (combat and support elements).

a. Demographic Data.

(1) Table 11 shows the demographic data of the 10thMt cohort. Junior enlisted (E1–E4), senior enlisted (E5–E8), and officers (O1-O4) made up 74%, 20%, and 6% of the cohort, respectively. Individuals who were high school graduates, unmarried, and of White ethnicity made up 44% of the cohort. The average±SD age was 24.1±4.9 years, with a range of 17 to 42 years.

Table 11. Demographic Data on 10thMt Cohort

Variable	n	Proportion of Soldiers (%)
Grade		
E1	20	4.0
E2	78	15.4
E3	220	43.6
E4	54	10.7
E5	53	10.5
E6	32	6.3
E7	14	2.8
E8	1	0.2
O1	16	3.2
O2	5	1.0
O3	7	1.4
O4	1	0.2
Missing[a]	4	0.8

Table 11. Demographic Data on 10thMt Cohort (continued)

Variable	n	Proportion of Soldiers (%)
Educational Level		
<High School Graduate	4	0.8
High School Graduate	438	86.7
College Graduate	37	7.3
Missing[a]	26	5.1
Marital Status		
Single	341	67.5
Married	155	30.7
Other	5	1.0
Missing[a]	4	0.8
Race/Ethnicity		
Asian/Pacific Islander	22	4.4
Black	59	11.7
Hispanic	40	7.9
Native American	6	1.2
White	371	73.5
Missing[a]	7	1.4

Note:
[a] No data were found in the DMDC database

(2) Table 12 shows the demographic data of the 1stCav cohort. Junior enlisted (E1–E4), senior enlisted (E5–E9), officers (O1–O6), and warrant officers made up 57%, 34%, 9%, and 1% of the cohort, respectively. Individuals who were high school graduates, single, and of White ethnicity made up 27% of the cohort. The average±SD age was 26.4±6.4 years for the men and 25.8±6.3 years for the women. Ages ranged from 17 to 50 years for the men and from 17 to 44 years for the women.

Table 12. Demographic Data on 1stCav Cohort

Variable	Men		Women		Men and Women	
	n	Proportion of Soldiers (%)	n	Proportion of Soldiers (%)	n	Proportion of Soldiers (%)
Grade						
E1	71	2.2	6	2.4	77	2.2
E2	653	20.1	56	22.0	709	20.3
E3	356	11.0	39	15.4	395	11.3
E4	752	23.2	44	17.3	796	22.8
E5	559	17.2	41	16.1	600	17.2
E6	339	10.5	22	8.7	361	10.3
E7	147	4.5	10	3.9	157	4.5
E8	43	1.3	3	1.2	46	1.3
E9	10	0.3	0	0.0	10	0.3
O1	112	3.5	9	3.5	121	3.5
O2	22	0.7	4	1.6	26	0.7
O3	93	2.9	11	4.3	104	3.0
O4	29	0.9	1	0.4	30	0.9
O5	7	0.2	0	0.0	7	0.2
O6	1	0.0	0	0.0	1	0.0
WO1	10	0.3	1	0.4	11	0.3
WO2	9	0.3	0	0.0	9	0.3
WO3	5	0.2	0	0.0	5	0.1
WO5	1	0.0	0	0.0	1	0.0
Missing[a]	23	0.7	7	2.8	30	0.9
Educational Level						
<High School Graduate	40	1.2	1	0.4	41	1.2
High School Graduate	2794	86.2	209	82.3	3003	85.9
College Graduate	334	10.3	34	13.4	368	10.5
Missing[a]	74	2.3	10	3.9	84	2.4
Marital Status						
Single	1519	46.9	114	44.9	1633	46.7
Married	1608	49.6	115	45.3	1723	49.3
Other	91	2.8	18	7.1	109	3.1
Missing[a]	24	0.7	7	2.8	31	0.9

Table 12. Demographic Data on 1stCav Cohort (continued)

Variable	Men		Women		Men and Women	
	n	Proportion of Soldiers (%)	n	Proportion of Soldiers (%)	n	Proportion of Soldiers (%)
Race/Ethnicity						
Asian/Pacific Islander	122	3.8	17	6.7	139	4.0
Black	542	16.7	87	34.3	629	18.0
Hispanic	545	16.8	45	17.7	590	16.9
Native American	37	1.1	1	0.4	38	1.1
White	1909	58.9	88	34.6	1997	57.1
Missing[a]	87	2.7	16	6.3	103	2.9

Note:
[a] No data were found in the DMDC database

b. Injury Data.

(1) Table 13 shows the cumulative injury incidence before and after the deployment of the 10thMt cohort. There was little difference in injury incidence between the two predeployment periods (Periods 1 and 2) and little difference when either of the two predeployment periods (Periods 1 and 2) were compared with the first postdeployment period (Period 3). The exception was the OII, which was elevated in the first postdeployment period compared with the first predeployment period. The second postdeployment period (Period 4) had a higher injury incidence than the three earlier periods (Periods 1, 2, or 3). The proportional magnitude of the increase in Period 4 for overuse injuries (OII) was larger than that for the other injury indices.

Table 13. Cumulative Injury Incidence Before and After Deployment of the 10thMt Cohort (n=505 Men)

Injury Index	Injury Incidence								p-value (McNemar Test)					
	Predeployment				Postdeployment									
	Period 1		Period 2		Period 3		Period 4		Period 1 vs Period 2	Period 3 vs Period 4	Period 1 vs Period 3	Period 1 vs Period 4	Period 2 vs Period 3	Period 2 vs Period 4
	n	%	n	%	n	%	n	%						
III	63	12.5	65	12.9	75	14.9	100	19.8	0.91	0.01	0.26	<0.01	0.38	<0.01
MIII	70	13.9	68	13.5	81	16.0	113	22.4	0.92	<0.01	0.32	<0.01	0.26	<0.01
TRII	35	6.9	37	7.3	39	7.7	62	12.3	0.89	<0.01	0.71	<0.01	0.90	0.01
OII	35	6.9	42	8.3	55	10.9	84	16.6	0.40	<0.01	0.02	<0.01	0.17	<0.01
CII	71	14.1	71	14.1	83	16.4	118	23.4	0.99	<0.01	0.27	<0.01	0.31	<0.01

(2) Table 14a shows the cumulative injury incidence before and after the deployment of the 1stCav cohort. Among men, injury incidence was lower in Period 2 than in Period 1. In the postdeployment period, men had higher injury incidence in Period 4 than in Period 3. In the first postdeployment period, men's injury incidence was more than twice as high as in the first

predeployment period (Period 3 versus Period 1). In the second postdeployment period it was almost three times as great as in the first pre-deployment period (Period 4 versus Period 1). The magnitude of the postdeployment injury increase was larger for the overuse injury indices (TRII and OII) than for the other injury indices.

Table 14a. Injury Incidence Before and After Deployment of the 1stCav Cohort – Men (n=3242)

Injury Index	Injury Incidence								p-value (McNemar Test)					
	Predeployment				Postdeployment									
	Period 1		Period 2		Period 3		Period 4		Period 1 vs Period 2	Period 3 vs Period 4	Period 1 vs Period 3	Period 1 vs Period 4	Period 2 vs Period 3	Period 2 vs Period 4
	n	%	n	%	n	%	n	%						
III	444	13.7	355	11.0	1052	32.4	1307	40.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MIII	472	14.6	375	11.6	1108	34.2	1367	42.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TRII	279	8.6	196	6.0	680	21.0	888	27.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
OII	315	9.7	262	8.1	795	24.5	1055	32.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CII	488	15.1	401	12.4	1148	35.4	1408	43.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

(3) The women of the 1stCav displayed a somewhat different injury pattern than the men, as Table 14b shows. Regardless of the injury index, there was little difference in injury rates between the two predeployment periods (Periods 1 and 2) or between the two postdeployment periods (Periods 3 and 4), although incidence was slightly higher in Period 4. Injury incidence was higher in both postdeployment periods (Period 3 or 4) when compared with either predeployment period (Period 1 or 2). In the first postdeployment period, injury incidence for several injury indices (III, TRII, OII) was more than twice as high as in the first predeployment period (Period 3 versus Period 1). In the second postdeployment period, injury incidence for all injury indices was more than twice as high as in the first predeployment period (Period 4 versus Period 1).

Table 14b. Injury Incidence Before and After Deployment of the 1stCav Cohort – Women (n=254)

Injury Index	Injury Incidence								p-value (McNemar Test)					
	Predeployment				Postdeployment									
	Period 1		Period 2		Period 3		Period 4		Period 1 vs Period 2	Period 3 vs Period 4	Period 1 vs Period 3	Period 1 vs Period 4	Period 2 vs Period 3	Period 2 vs Period 4
	n	%	n	%	n	%	n	%						
III	41	16.1	44	17.3	82	32.3	95	37.4	0.77	0.17	<0.01	<0.01	<0.01	<0.01
MIII	46	18.1	47	18.5	86	33.9	103	40.6	0.99	0.08	<0.01	<0.01	<0.01	<0.01
TRII	25	9.8	30	11.8	57	22.4	71	28.0	0.51	0.11	<0.01	<0.01	<0.01	<0.01
OII	31	12.2	37	14.6	71	28.0	84	33.1	0.44	0.17	<0.01	<0.01	<0.01	<0.01
CII	48	18.9	49	19.3	92	36.2	107	42.1	0.99	0.12	<0.01	<0.01	<0.01	<0.01

(4) Table 15 shows the risk of postdeployment injury for those Soldiers who had predeployment injuries in the 10thMt cohort. For all injury indices other than the TRII, the risk of postdeployment injury was higher among Soldiers who had predeployment injuries. For the TRII, the absolute risk of postdeployment injury was higher for Soldiers who had predeployment injury in three of the four comparisons, but the differences were smaller than for the other indices. For all overuse injuries (OII), the risk of postdeployment overuse injury was particularly high (risk ratio range 2.24–3.75) among Soldiers who had previous overuse injuries.

Table 15. Risk of Postdeployment Injury among Soldiers Who Had Predeployment Injuries (10thMt Cohort)

Injury Index	Comparison	No Predeployment Injury (% with postdeployment injury)	Predeployment Injury (% with postdeployment injury)	Risk Ratio (95%Confidence Interval) (predeployment injury/ no predeployment injury)	p-value (chi-square statistic)
III	Periods 1 & 3	12.2	33.3	2.72 (1.77–4.81)	<0.01
	Periods 1 & 4	18.6	28.6	1.54 (1.00–2.38)	0.06
	Periods 2 & 3	13.4	24.6	1.83 (1.13–2.99)	0.03
	Periods 2 & 4	17.3	36.9	2.14 (1.46–3.11)	<0.01
MIII	Periods 1 & 3	12.9	35.7	2.78 (1.86–4.13)	<0.01
	Periods 1 & 4	20.5	34.3	1.67 (1.15–2.43)	<0.01
	Periods 2 & 3	14.4	26.5	1.83 (1.16–2.90)	<0.01
	Periods 2 & 4	19.7	39.7	2.02 (1.42–2.86)	<0.01
TRII	Periods 1 & 3	7.2	14.3	1.97 (0.82–4.74)	0.13
	Periods 1 & 4	12.1	14.3	1.18 (0.50–2.75)	0.71
	Periods 2 & 3	7.5	10.8	1.45 (0.54–3.85)	0.47
	Periods 2 & 4	12.4	10.8	0.87 (0.34–2.27)	0.77
OII	Periods 1 & 3	9.1	34.3	3.75 (2.18–6.41)	<0.01
	Periods 1 & 4	15.3	34.3	2.24 (1.35–3.70)	<0.01
	Periods 2 & 3	9.5	26.2	2.75 (1.54–4.93)	<0.01
	Periods 2 & 4	14.9	35.7	2.40 (1.51–3.80)	<0.01
CII	Periods 1 & 3	12.9	38.0	2.95 (2.01–4.33)	<0.01
	Periods 1 & 4	21.2	36.6	1.73 (1.21–2.46)	<0.01
	Periods 2 & 3	15.0	25.4	1.69 (1.07–2.67)	<0.01
	Periods 2 & 4	21.0	38.0	1.81 (1.28–2.57)	<0.01

(5) Table 16a shows the risk of a postdeployment injury among male Soldiers in the 1stCav cohort if they had a predeployment injury. For all injury indices, the risk of a postdeployment injury among the men was 1.37 to 1.96 times higher for those who had predeployment injuries. Risk was somewhat higher for the two overuse indices (TRII and OII) compared to the other indices. Among the women (Table 16b), the results were not as clear. In 14 of 20 comparisons the absolute risk of a postdeployment injury was higher for female Soldiers had predeployment injuries. Comparison of Periods 1 and 4 showed higher risk in the more general and comprehensive indices (III, MIII, and CII) but not in the indices that emphasize overuse injuries (OII and TRII).

Table 16a. Risk of Postdeployment Injury with Prior Predeployment Injury (1stCav Cohort) – Men

Injury Index	Comparison	No Predeployment Injury (% with postdeployment injury)	Predeployment Injury (% with postdeployment injury)	Risk Ratio (95%Confidence Intervals) (predeployment injury/ no predeployment injury)	p-value (chi-square statistic)
III	Periods 1 & 3	30.5	45.0	1.48 (1.32–1.61)	<0.01
	Periods 1 & 4	38.2	53.8	1.41 (1.28–1.56)	<0.01
	Periods 2 & 3	30.5	48.2	1.58 (1.40–1.78)	<0.01
	Periods 2 & 4	38.7	53.8	1.39 (1.25–1.55)	<0.01
MIII	Periods 1 & 3	32.2	45.8	1.42 (1.27–1.59)	<0.01
	Periods 1 & 4	39.8	56.1	1.41 (1.29–1.55)	<0.01
	Periods 2 & 3	32.2	49.6	1.54 (1.38–1.73)	<0.01
	Periods 2 & 4	40.4	56.0	1.39 (1.25–1.53)	<0.01
TRII	Periods 1 & 3	19.9	32.2	1.62 (1.35–1.95)	<0.01
	Periods 1 & 4	26.5	36.9	1.39 (1.18–1.64)	<0.01
	Periods 2 & 3	19.9	37.8	1.90 (1.56–2.30)	<0.01
	Periods 2 & 4	26.7	37.8	1.41 (1.17–1.71)	<0.01
OII	Periods 1 & 3	23.4	34.9	1.49 (1.27–1.76)	<0.01
	Periods 1 & 4	31.3	44.4	1.42 (1.24–1.62)	<0.01
	Periods 2 & 3	22.8	44.7	1.96 (1.69–2.28)	<0.01
	Periods 2 & 4	31.1	49.2	1.58 (1.38–1.81)	<0.01
CII	Periods 1 & 3	33.4	46.9	1.41 (1.26–1.57)	<0.01
	Periods 1 & 4	41.1	56.6	1.38 (1.26–1.51)	<0.01
	Periods 2 & 3	33.2	50.9	1.53 (1.37–1.71)	<0.01
	Periods 2 & 4	41.5	56.9	1.37 (1.24–1.51)	<0.01

Table 16b. Risk of Postdeployment Injury with Prior Predeployment Injury (1stCav Cohort) – Women

Injury Index	Comparison	No Predeployment Injury (% with postdeployment injury)	Predeployment Injury (% with postdeployment injury)	Risk Ratio (95%Confidence Intervals) (predeployment injury/ no predeployment injury)	p-value (chi-square statistic)
III	Periods 1 & 3	31.5	36.6	1.16 (0.74–1.82)	0.52
	Periods 1 & 4	35.7	46.3	1.30 (0.89–1.89)	0.20
	Periods 2 & 3	32.4	31.8	0.98 (0.61–1.58)	0.94
	Periods 2 & 4	37.1	38.6	1.04 (0.69–1.57)	0.85
MIII	Periods 1 & 3	33.2	37.0	1.11 (0.73–1.70)	0.62
	Periods 1 & 4	38.0	52.2	1.37 (0.99–1.90)	0.08
	Periods 2 & 3	34.3	31.9	0.93 (0.59–1.47)	0.76
	Periods 2 & 4	38.2	51.1	1.34 (0.96–1.86)	0.10
TRII	Periods 1 & 3	22.3	24.0	1.08 (0.51–2.26)	0.85
	Periods 1 & 4	27.9	28.0	1.00 (0.52–1.94)	0.99
	Periods 2 & 3	22.8	20.0	0.88 (0.41–1.87)	0.73
	Periods 2 & 4	27.7	30.0	1.08 (0.60–1.95)	0.79

Table 16b. Risk of Postdeployment Injury with Prior Predeployment Injury (1stCav Cohort) – Women (continued)

Injury Index	Comparison	No Predeployment Injury (% with postdeployment injury)	Predeployment Injury (% with postdeployment injury)	Risk Ratio (95%Confidence Intervals) (predeployment injury/ no predeployment injury)	p-value (chi-square statistic)
OII	Periods 1 & 3	27.8	29.0	1.04 (0.58–1.88)	0.89
	Periods 1 & 4	33.2	32.2	0.97 (0.56–1.67)	0.98
	Periods 2 & 3	28.1	27.0	0.96 (0.54–1.70)	0.89
	Periods 2 & 4	32.7	35.1	1.07 (0.67–1.73)	0.77
CII	Periods 1 & 3	35.0	41.7	1.19 (0.81–1.75)	0.38
	Periods 1 & 4	39.0	54.2	1.38 (1.00–1.88)	0.06
	Periods 2 & 3	31.1	31.7	1.02 (0.68–1.53)	0.93
	Periods 2 & 4	39.5	53.1	1.34 (0.98–1.84)	0.08

c. Physical Characteristics and Fitness.

(1) Table 17 shows a comparison of the pre- and postdeployment physical characteristics and APFT scores of the 10thMt cohort. As expected, there were no differences in pre- and postdeployment height. Postdeployment weight averaged 3 lb higher than predeployment weight (2%) and postdeployment BMI averaged 0.5 kg/m^2 higher than predeployment BMI (2%). The APFT raw scores showed very small pre-post differences, and the mean total APFT points were identical in the pre- and postdeployment periods.

Table 17. Comparison of Pre- and Postdeployment Physical Characteristics and APFT Scores of the 10thMt Cohort

Variable	n	Pre-deployment (mean±SD)	Post-deployment (mean±SD)	p-value[a]
Height (in)	142	70 ±3	70 ±3	0.93
Weight (lb)	142	176 ±26	179 ±26	<0.01
Body Mass Index (kg/m^2)	142	25.4 ±3.3	25.9 ±3.4	<0.01
Push-Ups (repetitions)	178	64 ±13	66 ±13	0.15
Sit-Ups (repetitions)	178	68 ±11	68 ±11	0.26
2-Mile Run Time (min)	178	14.7 ±1.2	14.6 ±1.6	0.61
Total Score (points)	178	250 ±30	250 ±38	0.83

Legend:
in=inches, lb=pounds, kg=kilograms, m=meters, min=minutes
SD=standard deviation

Note:
[a] From paired t-test

(2) Table 18 shows a comparison of the pre- and postdeployment physical characteristics and APFT scores for the 1stCav cohort. For the men, pre- and postdeployment height did not differ. Body weight averaged 9 lb (5%) higher in the postdeployment period, and postdeployment BMI was 1.0 kg/m^2 (4%) higher. Male Soldiers averaged 2 more postdeployment push-ups (3%), but 2 less postdeployment sit-ups (3%). Run times averaged 0.7 minutes slower in the postdeployment period (5%). Men averaged 6 fewer APFT points in the postdeployment period (3%).

(3) The unit provided little data on the 1stCav women, as Table 18 shows. Despite this, the pattern was similar to the men. Body weight averaged 7 lb (5%) higher in the postdeployment period, and postdeployment BMI was 1.2 kg/m^2 (5%) higher. Female Soldiers averaged 5 fewer postdeployment push-ups (15%), but one more postdeployment sit-up (2%). Run times averaged 1.5 minutes slower in the postdeployment period (8%). Women averaged 13 fewer APFT points in the postdeployment period (6%).

Table 18. Comparison of Pre- and Postdeployment Physical Characteristics and APFT Scores of the 1stCav Cohort

Variable	Men				Women			
	n	Pre-deployment (mean±SD)	Post-deployment (mean±SD)	p-value[a]	n	Pre-deployment (mean±SD)	Post-deployment (mean±SD)	p-value[a]
Height (in)	29	70 ±2	70 ±2	0.44	3	63 ±2	63 ±2	0.45
Weight (lb)	27	176 ±20	185 ±23	0.01	3	140 ±9	147 ±7	0.45
Body Mass Index (kg/m^2)	27	25.7 ±2.8	26.7 ±3.0	0.02	3	24.7 ±1.7	25.9 ±2.2	0.44
Push-Ups (repetitions)	84	60 ±14	62 ±18	0.06	6	33 ±12	28 ±13	0.17
Sit-Ups (repetitions)	83	65 ±11	63 ±14	0.28	6	59 ±10	60 ±14	0.79
2-Mile Run Time (min)	76	15.0 ±1.4	15.7 ±1.7	<0.01	6	18.8 ±0.8	20.3 ±1.6	0.04
Total Score (points)	75	236 ±38	230 ±45	0.17	6	234 ±32	221 ±36	0.25

Legend:
in=inches, lb= pounds, kg=kilograms, m=meters, min=minutes
SD=standard deviation

Note:
[a]From paired t-test

7. DISCUSSION. This investigation examined the outpatient injury and physical fitness experience of Soldiers just before and just after deployments to Afghanistan (10thMt cohort) and Iraq (1stCav cohort). Both cohorts exhibited a postdeployment increase in cumulative injury incidence compared with the predeployment incidence, although the pattern and magnitude of the increase differed in the two cohorts. For physical fitness, both male groups showed little difference in pre- versus postdeployment muscular endurance (push-up and sit-up performance), but demonstrated a small gain in body weight and BMI in the postdeployment period. Women also had a postdeployment gain in body weight and BMI, and push-up performance declined. Aerobic fitness (2-mile run times) results differed in the two cohorts: the 10thMt (Afghanistan)

group showed no difference in pre- versus postdeployment performance, while the 1stCav cohort (Iraqi deployment) showed a decline in aerobic performance.

a. Injury Incidence.

(1) As noted in the introduction, a number of studies have examined various aspects of pre- and postdeployment hospitalizations,[18-30] mortality,[31-52] and self-reported injury.[49, 53-55] However, the present study is the first to compare pre- and postdeployment outpatient injury experience and show a postdeployment increase. Hypotheses regarding potential intrinsic (personal) factors that may have contributed to the increase have been well outlined by Bell et al.[72] These factors may include (1) psychological stress due to post-traumatic stress syndrome or depression that may increase injury rates[33, 40, 45, 46, 72-76], (2) adoption of unhealthy coping behaviors like alcohol and drug abuse[55, 67, 77-82], (3) ill-defined diseases and syndromes acquired in-theater that might affect factors like decision making, balance, navigation, reaction time, and the like,[25, 55, 72, 83-86] (4) comorbities associated with injuries experienced in-theater,[24, 55] and/or (5) increased postdeployment risk taking.[40, 44-46, 48, 56, 59, 87] In addition to these potential intrinsic factors, extrinsic (external) factors may contribute to the increase in postdeployment injuries. These might include the in-garrison pre- versus postdeployment operational tempo, military training activities, physical training activities, deployment location, activities in theater, length of deployment, hazardous exposures in theater, and environmental conditions. Although the present study documents a higher postdeployment injury rate, the data collected here cannot determine the extent to which either intrinsic or extrinsic factors may have contributed to the change.

(2) Predeployment injury incidence was similar in the 10thMt and 1stCav cohorts. However, the postdeployment injury experience of the two groups differed. Although both groups eventually had higher postdeployment injury incidence, the pattern and size of the increase differed. The 10thMt showed little rise in injury incidence immediately postdeployment (Period 3), but a larger increase later (Period 4). The absolute increase in injury incidence in the 10thMt group was generally less than half that in the 1stCav cohort. More specifically, in the 10thMt cohort, injury incidence was only moderately elevated by 1.1 to 1.6 times in the first 90-day postdeployment period (Period 3) when compared with the two predeployment periods. The 1stCav cohort showed a much larger 1.8 to 3.5 times increase when the first postdeployment period (Period 3) was compared to the two predeployment periods. In the second postdeployment period (Period 4), the injury incidences of the 10thMt cohort were elevated 1.6–2.4 times compared with the two predeployment periods, while the 1stCav cohort demonstrated an elevation 2.2 to 4.6 times that of the predeployment periods.

(3) The lower overall posdeployment injury incidence in the 10thMt cohort could be due to a number of factors, among which might be (1) the time of year when the first postdeployment period occurred, (2) the physical training program the unit was using, (3) the differences in the

occupational tasks of the Soldiers, and/or (4) in-theater differences. With regard to the time of year, the 10thMt group returned from deployment in December and there was little field training in this time. Soldiers also had 2 weeks of block leave during the holiday season at the end of December and there were generally few visits for injuries over block leave period.[88] During the predeployment period, at least two week-long overnight field exercises occurred and Soldiers were constantly training in anticipation of tasks they would perform while deployed. The first postdeployment period (Period 3) included considerably fewer field training exercises and no overnight field training. With less field training, Soldiers may have been less exposed to potential injury-producing events. The 1stCav cohort postdeployment period began on 3 January and thus the block leave period was not included. We are unsure about the amount of postdeployment training the 1stCav conducted.

(4) In addition to the time of year, the physical training program may have influenced injury rates. The 10thMt units under investigation had implemented the new Physical Readiness Training (PRT) program prior to deployment and continued to use it after deployment. PRT is the physical training doctrine designed by the US Army Physical Fitness School to improve Soldiers' physical capability for military operations. It closely follows the exercise principles of progressive overload, regularity, specificity, precision, variety, and balance. Specificity was achieved by examining the standard list of military (warrior) tasks and determining (1) the physical requirements, (2) the fitness components involved, and (3) the training activities that could most likely improve the military tasks.[89] In both Basic Combat Training and Ordnance Advanced Individual Training, PRT has been shown to substantially reduce the overall incidence of injury.[90-92] Injury-prevention features include reduced running mileage, exercise variety (cross-training), as well as gradual, prescriptive, progressive training. It is possible that the lower postdeployment injury rate in the 10thMt cohort could have been influenced by the PRT program. PRT was not the formal physical training doctrine during the time the project was being conducted, because the PRT manual was still in staffing and the older physical training doctrine[69] was still formally in place. Unfortunately, we were unable to determine whether the 1stCav cohort was using the new or older doctrine.

(5) Differences in the occupational tasks of the Soldiers may have influenced differences in the pattern and magnitude of the postdeployment injury rates. In an effort to explore this possibility, we requested from the AFHSC the MOSs of the Soldiers involved in the project. In the 10thMt group, 401 of the 505 Soldiers (79%) had an 11 Series MOS (infantry), with the remainder consisting of artillery (n=32), signal (n=23), medical (n=24) and other (n=25). Only 626 of the 1stCav male cohort (19%) had an 11 Series (infantry) MOS. Table 19 shows injury incidence among the 1stCav Soldiers whose MOS was in the 11 Series. The injury pattern of these infantry Soldiers was similar to that of the larger 1stCav group; that is, there was a slight decline in injury incidence from Period 1 to Period 2 and higher injury rates in the post-deployment periods (Periods 3 and 4) compared with the predeployment periods (Periods 1 and

2). MOS is only a surrogate for potential tasks the Soldiers may have performed. It is possible that the day-to-day occupational tasks differed in the two cohorts.

Table 19. Cumulative Injury Incidence Before and After Deployment of Soldiers with an Infantry MOS in the 1stCav Cohort (n=626)

Injury Index	Injury Incidence								p-value (McNemar Test)					
	Pre Deployment				Post-Deployment									
	Period 1		Period 2		Period 3		Period 4		Period 1 vs Period 2	Period 3 vs Period 4	Period 1 vs Period 3	Period 1 vs Period 4	Period 2 vs Period 3	Period 2 vs Period 4
	n	%	n	%	n	%	n	%						
III	83	13.3	65	10.4	192	30.7	280	44.7	0.08	<0.01	<0.01	<0.01	<0.01	<0.01
MIII	89	14.2	68	10.9	205	32.7	289	46.2	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
TRII	47	7.5	35	5.6	132	21.1	197	31.5	0.11	<0.01	<0.01	<0.01	<0.01	<0.01
OII	53	8.5	46	7.3	152	24.3	213	34.0	0.43	<0.01	<0.01	<0.01	<0.01	<0.01
CII	93	14.9	72	11.5	208	33.2	294	47.0	0.04	<0.01	<0.01	<0.01	<0.01	<0.01

(6) Finally, in-theater differences may account for some of the between-cohort differences in injury rates. The 10thMt group was engaged primarily in classic combat operations involving patrolling and search-and-destroy missions in mountainous terrain. The 1stCav group was involved primarily in counter-insurgency operations in and around Baghdad and Mosul, Iraq. Different physical and psychological stressors were likely involved that could differentially influence postdeployment injury rates. Psychological stress can increase the incidence of injuries through a number of mechanisms,[93-97] especially through effects on the immune system[94] that can that affect tissue healing.[98-101] There was generally a larger postdeployment increase in the overuse injury indices (TRII and OII). Overuse injuries, which are due to repetitive microtrauma, might be expected to be most affected by reductions in tissue healing.

(7) The data on the 10thMt cohort is relatively consistent with a previous report[102] that evaluated a subsample of the present cohort and used different methods of data collection. In this previous study, the paper medical records of 323 of the 10thMt Soldiers (64% of the current cohort) were screened for injuries occurring from 215 to 137 days before deployment and the 78-day period immediately after return from deployment. Injury rates from that study showed no significant differences in injury rates in the pre- versus postdeployment periods. In the present study, injury incidence was modestly elevated, but in only one of the five injury indices (OII) were the pre-post differences statistically significant. The larger sample size in the present study, different pre- and postdeployment survey times, and differences in injury definitions may account for the minor differences.

(8) In past studies, deployed service members hospitalized prior to deployment were more likely to be hospitalized after deployment.[19, 21-24, 27] Our previous investigation of the 10thMt cohort over a shorter follow-up time demonstrated for the first time that deployed Soldiers with predeployment outpatient injury medical visits were more likely to make outpatient

visits for similar injuries in the postdeployment period.[88] The present study confirmed in a new cohort (1stCav) that predeployment outpatient injuries put male Soldiers at higher risk of a postdeployment injury. In consonance with the previous study,[88] predeployment outpatient overuse injuries (OII), particularly, put male Soldiers at higher risk of postdeployment overuse injuries. The results for the women were not as clear, perhaps because of the smaller number of women. Soldiers who deploy with minor injuries in the predeployment period may find those injuries exacerbated during deployment. The quality of treatment and the nature of the Soldier's missions in theater are likely to determine the recurrence of an injury. Chronic conditions may result in return visits to medical care providers regardless of deployment status. In general agreement with the results reported here, previous studies of athletes,[103-107] industrial workers,[108] and other military groups[109, 110] reported that prior injuries were associated with subsequent injuries, especially if the earlier injury occurred during the previous year.

(9) One problem with the current analysis is that it does not take into account whether or not each deployed Soldier was in their unit for the entire pre- and postdeployment periods. The time at risk would be less for Soldiers who entered the deployed unit after the start of the predeployment period or left the deployed unit before the end of the postdeployment period. Nonetheless, these Soldiers would likely be exposed to similar injury-producing hazards in other assigned units because it is unlikely that their MOS or physical training programs would have changed substantially. The 10thMt group was able to supply us with the dates their Soldiers entered and left the unit. Only 13 Soldiers (3% of the cohort) were not present for the entire pre- or postdeployment time. Table 20 shows the results after these Soldiers were eliminated and the cumulative injury incidence recalculated. The results are almost identical to those obtained for the whole cohort. Similar data were unavailable for the 1stCav cohort.

Table 20. Cumulative Injury Incidence Before and After Deployment of the 10thMt Cohort Including Only Soldiers Present in the Unit during the Entire Survey Period (n=492)

Injury Index	Injury Incidence								p-value (McNemar Test)					
	Predeployment				Postdeployment									
	Period 1		Period 2		Period 3		Period 4							
	n	%	n	%	n	%	n	%	Period1 vs Period2	Period3 vs Period4	Period1 vs Period3	Period1 vs Period4	Period2 vs Period3	Period2 vs Period4
III	62	12.6	65	13.2	71	14.4	98	19.9	0.83	<0.01	0.41	<0.01	0.62	<0.01
MIII	69	14.0	67	13.6	77	15.7	110	22.4	0.92	<0.01	0.48	<0.01	0.39	<0.01
TRII	34	6.9	37	7.5	35	7.1	60	12.2	0.76	<0.01	0.99	<0.01	0.90	<0.01
OII	34	6.9	42	8.5	53	10.8	82	16.7	0.32	<0.01	0.02	<0.01	0.24	<0.01
CII	70	14.2	70	14.2	79	16.1	115	23.4	0.99	<0.01	0.42	<0.01	0.45	<0.01

(10) Another limitation to the present study has to do with how the ICD-9 codes were used to obtain the injury incidence data. Within each of the four periods, it was not known whether the visit to the medical care provider was for a new injury or was a follow-up for a previous injury. It would have been difficult to determine this because different medical care providers may have seen the Soldier on different visits and different providers may have used

different ICD-9 codes for the same patient complaint. Nonetheless, this method of determining which ICD-9 codes represented an injury was consistent across all four periods. Thus, injury incidences are comparable across the four periods because they were compiled in an identical manner.

b. Physical Fitness.

(1) APFTs were administered to Soldiers over a wide range of dates in both cohorts, as indicated in Table 10. We estimated the time of APFT administration in relation to deployment by examining the 50th percentile dates of APFT administration and deployment. Based on this assessment, 10thMt APFTs were administered 4.4 months prior to deployment and 5.8 months after return from deployment. The 1stCav APFTs were administered 5.6 months prior to deployment and 4.7 months after return from deployment.

(2) Pre- and post-deployment APFTs were obtained for only a small proportion of the surveyed cohorts. The units provided a number of pre- and postdeployment APFT scores but only 35% of the 10thMt cohort and 3% of the 10thMt cohort had data from both pre- and postdeployment. Thus, the APFT data were limited and the results of that analysis should be viewed with caution.

(3) To gain some impression of how representative the Soldiers who had both pre- and postdeployment data were, we compared their APFT scores with those of Soldiers who had data from only one test. Table 21 shows the results for the 10thMt cohort. The average scores in

Table 21. Comparison of APFT Scores Among 10thMt Soldiers with and without Complete Pre- and Postdeployment Scores[a]

Period	APFT Item	Soldiers with Both Pre- and Post-Deployment Scores		Soldiers with Only Pre- or Post-Deployment Scores		p-value[b]
		n	Mean ±SD	n	Mean ±SD	
Pre-Deployment	Push-up (n)	178	64 ±13	61	70 ±13	<0.01
	Sit-up (n)	178	68 ±11	61	70 ±11	0.39
	2-Mile Run (min)	178	14.7 ±1.2	59	14.8 ±1.6	0.43
	Total Score (points)	178	250 ±30	59	256 ±32	0.14
Post- Deployment	Push-up (n)	178	66 ±13	169	65 ±13	0.34
	Sit-up (n)	178	68 ±11	167	68 ±10	0.32
	2-Mile Run (min)	178	14.6 ±1.6	158	14.7 ±1.6	0.97
	Total Score (points)	178	250 ±30	158	251 ±39	0.39

Legend:
n=number
min=minutes
SD=standard deviation

Notes:
[a] There were a total of 239 predeployment scores or 47% of the cohort; there were a total of 347 postdeployment scores or 69% of the cohort.
[b] From independent sample t-test

both groups were very similar, except for push-ups, where the group having only one score demonstrated higher performance. Despite this, the Soldiers with both tests appear to be fairly representative of the Soldiers in the unit who took the APFT, although perhaps less fit on the predeployment push-ups.

(4) Table 22 compares the APFT scores of the 1stCav Soldiers who had both pre- and postdeployment APFTs with those of Soldiers with only one test. Among the men, predeployment scores were very similar for those having one or two tests. However, the postdeployment scores of those with both tests were higher on all test events: compared with Soldiers with only one test, Soldiers with both tests performed an average of 5 more push-ups and one more sit-up and completed the run 0.7 minutes faster. Thus, the male Soldiers with both tests appeared to be more fit in the postdeployment period than others with APFT scores.

Table 22. Comparison of APFT Scores Among 1stCav Soldiers with and without Complete Pre- and Postdeployment Scores[a]

Gender	Period	APFT Item	Soldiers with Both Pre- and Post-Deployment Scores		Soldiers with Only Pre- or Post-Deployment Scores		p-value[b]
			n	Mean ±SD	n	Mean ±SD	
Men	Pre-Deployment	Push-up (n)	84	60 ±14	195	62 ±13	0.33
		Sit-up (n)	83	65 ±11	196	66 ±11	0.32
		2-Mile Run (min)	76	15.0 ±1.4	185	15.3 ±1.5	0.28
		Total Score (points)	75	236 ±38	182	242 ±34	0.20
	Post- Deployment	Push-up (n)	84	62 ±18	228	57 ±13	<0.01
		Sit-up (n)	83	63 ±14	226	62 ±11	0.61
		2-Mile Run (min)	76	15.7 ±1.7	207	16.4 ±2.3	0.02
		Total Score (points)	75	230 ±45	214	221 ±40	0.08
Women	Pre-Deployment	Push-up (n)	6	33 ±12	7	27 ±9	0.34
		Sit-up (n)	6	59 ±10	7	56 ±10	0.61
		2-Mile Run (min)	6	18.8 ±0.8	7	18.8 ±1.4	0.94
		Total Score (points)	6	234 ±32	7	217 ±20	0.30
	Post- Deployment	Push-up (n)	6	28 ±13	24	37 ±10	0.05
		Sit-up (n)	6	60 ±14	24	65 ±14	0.45
		2-Mile Run (min)	6	20.3 ±1.6	21	18.1 ±1.4	<0.01
		Total Score (points)	6	221 ±36	21	246 ±33	0.11

Legend:
n=number
min=minutes
SD=standard deviation

Notes:
[a] For the men, there were a total of 279 predeployment and 312 postdeployment scores making, up 9% and 10% of the male cohort, respectively. For the women, there were a total of 13 predeployment and 30 postdeployment scores, making up 5% and 9% of the female cohort, respectively.
[b] From independent sample t-test

(5) Among the women, predeployment scores for those having one test and those with both tests were very similar. However, the women with both tests were considerably less fit in the postdeployment period: compared with Soldiers with only one test, Soldiers with both tests performed an average of 9 fewer push-ups and 3 fewer sit-ups, in addition to completing the run 2.2 minutes slower. Thus, the female Soldiers with both tests appeared to be considerably less fit in the postdeployment period than others with APFT scores.

(6) Gains in body weight and BMI in the postdeployment period occurred in both cohorts. The men in both cohorts had very similar pre- versus postdeployment push-up and sit-up scores. The very limited data (n=6) on women suggested some postdeployment decrement in push-up performance but little difference in sit-up performance. Aerobic fitness (2-mile run times) results differed in the two cohorts: the 10thMt group showed no difference in pre- and postdeployment performance, while the 1stCav cohort (men and women) showed a modest decline in aerobic performance. In accounting for the between-cohort differences, the physical training programs of the units should be considered. As noted earlier, the 10thMt cohort was using the PRT program, but we are not sure of the program of the 1stCav group.

(7) A subsample of the 10thMt cohort (n=110 men) was tested for selected physical fitness measures just before deployment and within about 18 days postdeployment. These results have been reported previously.[111] Treadmill-running VO_2max was about 5% lower on the postdeployment test compared with the predeployment test. The similarity of the pre- and postdeployment 2-mile run times in the present investigation suggests that the immediate postdeployment loss of aerobic fitness was regained within less than 6 months of return from deployment. The previous study of the subsample of 10thMt Soldiers[111] also showed that strength, measured as a one-repetition maximum (1RM) on the incremental dynamic lift,[112] was identical (74±13 kg) in the pre- and postdeployment periods, suggesting that Soldiers maintained their strength while on deployment. Muscular endurance was not measured in the previous study,[112] but since absolute muscle strength is highly related to absolute muscular endurance,[113] Soldiers may have maintained their muscular endurance in the immediate postdeployment period. Muscular endurance (push-up, sit-up performance) was certainly at predeployment levels about 6 months postdeployment. The extent to which the PRT program contributed to these changes cannot be determined.

(8) A subsample of the 1stCav cohort was also tested for selected physical fitness measures just before deployment and within 7 to 11 days postdeployment.[114] For 34 men who completed the pre and postdeployment 2-mile run, run times were 13% slower in the postdeployment period compared with the predeployment period (15.7±1.4 versus 17.7±2.5 minutes, $p<0.01$). In the present, study run times were 5% slower on the postdeployment APFT compared with the predeployment APFT (15.0±1.4 verses 15.7±1.7, $p<0.01$). While this might suggest that about 5 months postdeployment male Soldiers had regained much but not all of their aerobic fitness; this interpretation must be tempered with the fact that Soldiers in the pre-

postdeployment AFPT 2-mile run sample (n=34) may not have been representative of the larger group of postdeployment 1stCav men (see Table 22). The previous study[114] of a subsample of 1stCav men also showed that strength, measured as a 1RM on the bench press and squat, was 7% and 8% higher, respectively, in the postdeployment period compared with the predeployment period (n=74). Muscular endurance was not measured in the previous study,[114] but since absolute muscle strength is highly related to absolute muscular endurance[113] Soldiers may have at least maintained if not improved muscular endurance in the immediately postdeployment period. At any rate, about 5 months after deployment muscular endurance was at predeployment levels, at least among the men.

8. SUMMARY.

a. This investigation compared Soldier outpatient injury rates and physical fitness before and after deployments to Afghanistan (10thMt group) and Iraq (1stCav group). Compared with the predeployment period, outpatient injury incidence was elevated in the postdeployment period. The pattern and magnitude of the elevated postdeployment injury incidence differed by unit. The 10thMt cohort showed little postdeployment rise in the first 90 days postdeployment but a larger increase 90–180 days later. The absolute increase in injury incidence in the 10thMt group was generally less than half that of the 1stCav cohort. The 1stCav cohort demonstrated a substantial 2- to 3-fold rise in injury incidence in the first 90-day postdeployment period and a further 3- to 4-fold increase in the second 90-day period (compared with the predeployment periods). Those experiencing injuries in the predeployment period were more likely to experience them in the postdeployment period, especially for overuse injuries.

b. Pre- and postdeployment APFT scores and weight/height were obtained about 4 to 6 months before deployment and about 5 to 6 months after deployment on 35% of the 10thMt cohort and 3% of the 1stCav cohort. For the men, pre- versus postdeployment push-up and sit-up performance was similar but the women had lower postdeployment push-up performance. There was a gain in body weight (3 to 9 pounds on average) and consequently in BMI in the postdeployment period. Aerobic fitness (2-mile run times) results differed in the two cohorts: the 10thMt group showed no difference in pre- versus postdeployment performance while the 1stCav cohort showed a postdeployment decline.

9. CONCLUSION.

There are many intrinsic (personal) and extrinsic (external) factors that could have influenced the rise in postdeployment injury incidence. The present investigation cannot determine which factors caused or were associated with the elevated postdeployment injury incidence. Nonetheless, the data here indicate that injury incidence is elevated postdeployment and in some circumstances aerobic fitness may not be totally restored 6 months postdeployment.

10. RECOMMENDATIONS. Efforts should be focused on determining the activities that are associated with these injuries so that preventive strategies can be developed. Once these strategies are determined, they should be tested for efficacy in the postdeployment training environment.

\11. POINT OF CONTACT. The point of contact for this report is the principal investigator, Dr. Joseph Knapik of the USACHPPM Injury Prevention Program. He may be reached at 410-668-1324/3534 (commercial) or 584-1324/3534 (DSN) and by electronic mail at joseph.knapik@us.army.mil.

JOSEPH J. KNAPIK
Research Physiologist
Injury Prevention Program

Approved:

BRUCE H JONES
Manager, Injury Prevention Program

APPENDIX A
REFERENCES

1. U.S. Army (2005). Preventive Medicine. Technical Report No. 40-5, Washington DC: Headquarters, Department of the Army.

2. Hodge J.G. 2005. An enhanced approach to distinguishing public health practice and human subjects research. *Journal of Law, Medicine and Ethics,* Spring:2-19.

3. McKee K.T., Kortepeter M.G., and Ljaamo S.K. 1998. Disease and non-battle injury among United States Soldiers deployed in Bosnia-Herzegovina during 1997: summary primary care statistics for Operation Joint Guard. *Military Medicine,* 163:733-742.

4. Holcomb J.B., Stanbury L.G., Champion H.R., Wade C., and Bellamy R.F. 2006. Understanding combat casualty care statistics. *Journal of Trauma,* 60:397-401.

5. Mabry R.L., Holcomb J.B., Baker A.W., Cloonan C.C., Uhorchak J.M., Perkins E.E., Canfield A.J., and Hagman J.H. 2000. United States Army Rangers in Somalia: an analysis of combat casualties on an urban battlefield. *Journal of Trauma,* 49:515-529.

6. Harman D.R., Hooper T.I., and Gackstetter G.D. 2005. Aeromedical evacuations from operation Iraqi Freedom: a descriptive study. *Military Medicine,* 170:521-527.

7. Chambers L.W., Green D.J., Gillingham B.L., Sample K., Rhee P., C. Brown, Brethauer S., Nelson T., Narine N., Baker B., and Bohman H.R. 2006. The experience of the US Marine Corps' surgical shock trauma platoon with 417 operative combat casualties during a 12 month period of Operation Iraqi Freedom. *Journal of Trauma,* 60:1155-1164.

8. Marshall T.J. 2005. Combat casualty care: the alpha surgical company experience during operation Iraqi Freedom. *Military Medicine,* 170:469-472.

9. Murray C.K., Reynolds J.C., Schroeder J.M., Harrison M.B., Evans O.M., and Hospenthal D.R. 2005. Spectrum of care provided at an echelon II medical unit during operation Iraqi Freedom. *Military Medicine,* 170:516-520.

10. Zouris J.M., Walker G.J., Dye J., and Galarneau M. 2006. Wounding patterns for US Marines and Sailors during Operation Iraqi Freedom, major combat phase. *Military Medicine,* 171:246-252.

11. Place R.J., Rush R.M., and Arrington E.D. 2003. Forward surgical team (FST) workload in a special operations environment: the 250th FST in Operation Enduring Freedom. *Current Surgery,* 60:418-422.

12. Hinsley D.E., Rosell P.A.E., Rowlands T.K., and Clasper J.C. 2005. Penetrating missile injuries during asymmetric warfare in the 2003 Gulf conflict. *British Journal of Surgery,* 92:637-642.

13. Peoples G.E., Gerlinger T., Craig R., and Burlingham B. 2005. Combat casualties in Afghanistan cared for by a single forward surgical team during the initial phase of operation Enduring Freedom. *Military Medicine,* 170:462-468.

14. Soldo S., and Puntaric D. 1998. Injuries in Croatian Army brigade Soldiers inflicted in an offensive action during the 1991/1992 war in Croatia. *Military Medicine,* 163:420-422.

15. Appenzeller G.N. 2004. Injury patterns in peacekeeping missions: the Kosovo experience. *Military Medicine,* 169:187-191.

16. Bohnker B.K., Bowman W., Dell D., and Gutermuth F. 2005. Disease Nonbattle injury surveillance for commander, Joint Task Force Haiti, 2004. *Military Medicine,* 170:1032-1033.

17. Darakjy S., Marin R., Knapik J.J., and Ciechoski P. (2007). Combat injuries from a forward operating base in Iraq February 2005-July 2005. Technical Report No. 12-HF-032K-07, Aberdeen Proving Ground MD: US Army Center for Health Promotion and Preventive Medicine.

18. Beebe G.W. 1975. Follow-up studies of World War II and Korean War prisoners. II. Morbidity, disability and maladjustments. *American Journal of Epidemiology,* 101:400-422.

19. Smith B., Smith T.C., Ryan M.A.K., and Gray G.C. 2006. A comparison of the postdeployment hospitalization experience of U.S. military personnel following service in the 1991 Gulf War, Southwest Asia after the Gulf War, and Bosnia. *Journal of Occupational and Environmental Hygiene,* 3:660-670.

20. Blood C.G., and Aboumrad T.L. 2001. A comparison of postdeployment hospitalization incidence between active duty Vietnam and Persian Gulf War veterans. *Military Medicine,* 166:648-655.

21. Taubman S. 2007. Relationship between timing and causes of hospitalization before and after deploying to Iraq or Afghanistan, active components, U.S. Armed Forces, 2002-2005. *Medical Surveillance Monthly Report,* 13(2):3-7.

22. Brundage J.F., Kohlhase K.F., and Rubertone M.V. 2000. Hospitalizations for all causes of U.S. service members in relation to participation in operations Joint Endeavor and Joint Guard, Bosnia-Herzegovina, Janurary 1995 to December 1997. *Military Medicine,* 165:505-511.

23. Brundage J.F., Kohlhase K.F., and Gambel J.F. 2002. Hospitalization experience of U.S. servicemembers before, during and after participation in peacekeeping operations in Bosnia-Herzegovina. *American Journal of Industrial Medicine,* 41:279-284.

24. Gray G.C., Coate B.D., Anderson C.M., Kang H.K., Berg S.W., Wignall F.S., Knoke J.D., and Barrett-Connor E. 1996. The postwar hospitalization experience of U.S. veterans of the Persian Gulf War. *New England Journal of Medicine,* 335:1505-1513.

25. Gray G.C., Smith T.C., Knoke J.D., and Heller J.M. 1999. The postwar hospitalization experience of Gulf War veterans possibly exposed to chemical munitions destruction at Khamisiyah, Iraq. *American Journal of Epidemiology,* 150:532-540.

26. Gray G.C., Smith T.C., Kang H.K., and Knoke J.D. 2000. Are Gulf War veterans suffering war-related illnesses? Federal and civilian hospitalizations examined, June 1991 to December 1994. *American Journal of Epidemiology,* 151:63-71.

27. Smith T.C., Jimenez D.L., Smith B., Gray G.C., Hooper T.I., Gackstetter G.D., Heller J.M., Dalager N.A., Kang H.K., Hyams K.C., and Ryan M.A.K. 2004. The postwar hospitalization experience of Gulf War veterans participating in the U.S. health registries. *Journal of Occupational and Environmental Medicine,* 46:386-397.

28. Knoke J.D., and Gray G.C. 1998. Hospitalizations for unexplained illnesses among U.S. veterans of the Persian Gulf War. *Emerging Infectious Diseases,* 4:211-219.

29. Armed Forces Health Surveillance Center. 2007. Hospitalization experience within one year after returning from Afghanistan or Iraq, January 2002–September 2006. *Medical Surveillance Monthly Report,* 14(2):2-10.

30. Hooper T.I., DeBakey S.F., Nagaraj B.E., Bellis K.S., Smith B., Smith T.C., and Gackstetter G.D. 2008. The long-term hospitalization experience following military service in the 1991 Gulf War among veterans remaining on active duty, 1994–2004. *BMC Public Health,* 8:60.

31. Lawrence C.E., Reilly A.A., Quickenton P., Greenwald P., Page W.F., and Kuntz A.J. 1985. Mortality patterns of New York State Vietnam veterans. *American Journal of Public Health,* 75:277-279.

32. Breslin P., Kang H.K., Lee Y., Burt V., and Shepard B.M. 1988. Proportionate mortality study of US Army and US Marine Corps veterans of the Vietnam War. *Journal of Occupational Medicine,* 30:412-419.

33. Bullman T.A., Kang H.K., and Watanabe K.K. 1990. Proportionate mortality among US Army Vietnam veterans who served in military region I. *American Journal of Epidemiology,* 132:670-674.

34. Watanabe K.K., Kang H.K., and Thomas T.L. 1991. Mortality among Vietnam veterans: with methodological considerations. *Journal of Occupational Medicine,* 33:780-785.

35. Watanabe K.K., and Kang H.K. 1996. Mortality patterns among Vietnam veterans: a 24-year retrospective analysis. *Journal of Occupational and Environmental Medicine,* 38:272-278.

36. Adena M.A., Cobbin D.M., Fett M.J., Forcier L., Hudson H.M., Long A.A., Nairn J.R., and O'Toole B.I. 1985. Mortality among Vietnam veterans compared with non-veterans and the Australian population. *Medical Journal of Australia,* 143:541-544.

37. Fett M.J., Nairn J.R., Cobbin D.M., and Adena M.A. 1987. Mortality among Australian conscripts of the Vietnam conflict era. II. Causes of death. *American Journal of Epidemiology,* 125:878–884.

38. Thomas T.L., Kang H.K., and Dalager N.A. 1991. Mortality among women Vietnam Veterans, 1973–1987. *American Journal of Epidemiology,* 134:973-980.

39. Watanabe K.K., and Kang H.K. 1995. Military service in Vietnam and risk of death from trauma and selected cancers. *Annals of Epidemiology,* 5:407-412.

40. Boyle C.A., Decoufle P., Delaney R.J., DeStefano F., Flock M.L., Hunter M.I., Joesoef R., Karon J.M., Kirk M.L., Layde P.M., McGee D.L., Moyer L.A., Pollock D.A., Rhodes P., and Worth R.M. 1987. Postservice mortality among Vietnam veterans. *JAMA,* 257:790-795.

41. Dalager N.A., and Kang H.K. 1997. Mortality among Army Chemical Corps veterans. *American Journal of Industrial Medicine,* 31:719-726.

42. Keehn R.J. 1980. Follow-up studies of World War II and Korean Conflict prisoners. III. Mortality to January 1, 1976. *American Journal of Epidemiology,* 111:194-211.

43. Seltzer C.C., and Jablon S. 1974. Effects of selection on mortality. *American Journal of Epidemiology,* 100:367-372.

44. Nefzger M.D. 1970. Follow-up studies of World War II and Korean War prisoners. *American Journal of Epidemiology,* 91:123-138.

45. Kang H.K., and Bullman T.A. 1996. Mortality among U.S. veterans of the Persian Gulf War. *New England Journal of Medicine,* 335:1498-1504.

46. Kang H.K., and Bullman T.A. 2001. Mortality among US veterans of the Persian Gulf War: 7-year follow-up. *American Journal of Epidemiology*, 154:399-405.

47. MacFarlane G.J., Thomas E., and Cherry N. 2000. Mortality among UK Gulf War veterans. *Lancet,* 356:17-21.

48. MacFarlane G.J., Hotopf M., Maconochie N., Blatchley N., Richards A., and Lunt M. 2005. Long-term mortality amongst Gulf War veterans: is there a relationship with experiences during deployment and subsequent morbidity? *International Journal of Epidemiology*, 34:1403-1408.

49. Sim M., Abramson M., Forbes A., Glass D., Ikin J., Ittak P., Kelsall H., Leder K., McKenzie D., McNeil J., Creamer M., and Fritschi L. (2003). Australian Gulf War veterans' health study. Technical Report. Prahran, Victoria Australia: Monash University.

50. Kogan M.D., and Clapp R.W. (1985). Mortality among Vietnam veterans in Massachusetts, 1972–1983. Technical Report. Boston MA: Massachusetts Office of the Commissioner of Veterans Services, Agent Orange Program, and Department of Public Health, Division of Health Statistics and Research.

51. Anderson H.A., Hanrahan L.P., Jensen M., Laurin D., Yick W.Y., and Wiegman P. (1986). Wisconsin Vietnam veteran mortality study. Proportionate mortality ratio results. Technical Report. Madison WI: Wisconsin Department of Health and Human Services, Division of Health, Section of Environmental and Chronic Disease Epidemiology.

52. Cypel Y., and Kang H. 2008. Mortality patterns among woman Vietnam-era veterans: results of a retrospective cohort study. *Annals of Epidemiology,* 18:244-252.

53. Iowa Persian Gulf Study Group. 1997. Self-reported illness and health status among Gulf War veterans. *JAMA*, 277:238-245.

54. Zwerling C., Torner J.C., Clarke W.R., Voelker M.D., Doebbeling B.N., Barrett D.H., Merchant J.A., Wollson R.F., and Schwartz D.A. 2000. Self-reported postwar injuries among Gulf War veterans. *Public Health Reports,* 115:346-349.

55. Kang H.K., Mahan C.M., Lee K.Y., Magee C.A., and Murphy F.M. 2000. Illness among United States veterans of the Gulf War: a population-based survey of 30,000 veterans. *Journal of Occupational and Environmental Medicine,* 42:491-501.

56. Gray G.C., and Kang H.K. 2006. Health care utilization and mortality among veterans of the Gulf War. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences,* 361

57. Kuller L. 1995. The use of existing databases in morbidity and mortality studies. *American Journal of Public Health,* 85:1198-1200.

58. Cowan D.N., DeFraites R.F., Gray G.C., Goldenbaum M.B., and Wishik S.M. 1997. The risk of birth defects among children of Persian Gulf War veterans. *New England Journal of Medicine,* 336:1650-1656.

59. Bell N.S., Amoroso P.J., Williams J.O., Yore M.M., Engel C.C., Senier L., DeMattos A.C., and Wegman D.H. 2000. Demographic, physical, and mental health factors associated with deployment of U.S. Army soldiers to the Persian Gulf. *Military Medicine,* 165:762-772.

60. Writer J.V., Kang H., Lee K.L., and Kelly P.W. 1997. Pre-war hospitalization as a risk factor for enrollment on a Persian Gulf registry. *American Journal of Epidemiology,* 145:S340.

61. Gray G.C., Hawksworth A.W., Smith T.C., Kang H.K., Knoke J.D., and Gackstetter G.D. 1998. Gulf War Veterans' Health Registry: who is most likely to seek evaluation. *American Journal of Epidemiology,* 148:343-349.

62. Miller R.N., Costigan D.J., Young H.A., Kang H.K., Dalager N., Mathes R.W., Crewford H.C., Page W.F., and Thaul S. 2006. Patterns of health care seeking of Gulf War Registry members prior to deployment. *Military Medicine,* 171:370-375.

63. Army Medical Surveillance Activity. 2002. Hospitalizations among active duty members US Armed Forces, 2001. *Medical Surveillance Monthly Report,* 8:2-8.

64. Army Medical Surveillance Activity. 2005. Hospitalizations among active component members, US Armed Forces, 2004. *Medical Surveillance Monthly Report,* 11:2-11.

65. Visintainer P.F., Barone M., McGee H., and Peterson E.L. 1995. Proportionate mortality study of Vietnam-era veterans of Michigan. *Journal of Occupational and Environmental Medicine,* 37:423-428.

66. Fett M.J., Dunn M., Adena M.A., O'Toole B.I., and Forcier L. (1984). Australian veterans health studies. Part I. A retrospective cohort study of mortality among Australian National Servicemen of the Vietnam conflict era, and an executive summary of the mortality report. Technical Report. Canberra, Australia: Commonwealth Institute of Health in the University of Sidney.

67. Boehmer T.K., Flanders W.D., McGeehin M.A., Boyle C., and Barrett D.H. 2004. Postservice mortality in Vietnam veterans: 30-year follow-up. *Archives of Internal Medicine,* 164:1908-1916.

68. Knapik J.J., Darakjy S., Scott S., Hauret K.G., Canada S., Marin R., Palkoska F., VanCamp S., Piskator E., Rieger W., and Jones B.H. (2004). Evaluation of two Army fitness programs: the TRADOC Standardized Physical Training Program for Basic Combat Training and the Fitness Assessment Program. Technical Report No. 12-HF-5772B-04, Aberdeen Proving Ground, MD: US Army Center for Health Promotion and Preventive Medicine.

69. U.S. Army 1992. *Physical Fitness Training. U.S. Army Field Manual (FM) 21-20*. Washington, D.C.: Headquarters, Department of the Army.

70. Knapik J.J., Burse R.L., and Vogel J.A. 1983. Height, weight, percent body fat and indices of adiposity for young men and women entering the U.S. Army. *Aviation, Space and Environmental Medicine,* 54:223-231.

71. Fleiss J. 2003. *Statistical Methods for Rates and Proportions*. New York: John Wiley and Sons.

72. Bell N.S., Amoroso P.J., Wegman D.H., and Senier L. 2001. Proposed explanations for excess injury among veterans of the Persian Gulf War and a call for greater attention from policymakers and researchers. *Injury Prevention,* 7:4-9.

73. Drescher K.D., Rosen C.S., Burling T.A., and Foy D.W. 2003. Causes of death among male veterans who received residential treatment for PTSD. *Journal of Traumatic Stress,* 16:535543.

74. Bullman T.A., and Kang H.K. 1994. Posttraumatic stress disorder and the risk of traumatic deaths among Vietnam veterans. *Journal of Nervous and Mental Disease,* 182:604-610.

75. Boscarino J.A. 2006. External-cause mortality after psychological trauma: the effects of stress exposure and predisposition. *Comprehensive Psychiatry,* 47:503-514.

76. Boscarino J.A. 2006. Posttraumatic stress disorder and mortality among U.S. Army veterans 30 years after military service *Annals of Epidemiology,* 16:248-256.

77. Fischer V.J. 1991. Combat exposure and the etiology of postdischarge substance abuse problems among Vietnam veterans. *Journal of Traumatic Stress,* 4:251-277.

78. Reifman A., and Windle M. 1996. Vietnam combat exposure and recent drug use: a national study. *Journal of Traumatic Stress,* 9:557-568.

79. Pollock D.A., Boyle C.A., DeStefano F., Moyer L.A., and Kirk M.L. 1987. Underreporting of alcohol-related mortality on death certificates of young US Army veterans. *JAMA,* 258:345-348.

80. Lincoln A.E., Hooper T.I., Kang H.K., DeBakey S.F., Cowan D.N., and Gackstetter G.D. 2006. Motor vehicle fatalities among Gulf War era veterans: characteristics, mechanisms and circumstances. *Traffic Injury Prevention,* 7:31-37.

81. Hooper T.I., DeBakey S.F., Bellis K.S., Kang H.K., Cowan D.N., Lincoln A.E., and Gackstetter G.D. 2006. Understanding the effect of deployment on the risk of fatal motor vehicle crashes: a nested case-control study of fatalities in Gulf War era veterans, 1991–1995. *Accident Analysis and Prevention,* 38:518-525.

82. Centers for Disease Control and Prevention. 1987. Postservice mortality among Vietnam veterans. *Morbidity and Mortality Weekly Report,* 36:61-64.

83. Haley R.W., Kurt T.L., and Hom J. 1997. Is there a Gulf War syndrome? Searching for syndromes by factor analysis of symptoms. *JAMA,* 277:215-222.

84. Haley R.W., Hom J., Roland P.S., Bryan W.W., VanNess P.C., Bonte F.J., Devous M.D., Mathews D., Fleckenstein J.L., Wians F.H., Wolfe G.I., and Kurt T.L. 1997. Evaluation of neurologic function in Gulf War veterans. A blinded case-control study. *JAMA,* 277:223-230.

85. Gackstetter G.D., Hooper T.I., DeBakey S.F., Johnson A., Nagaraj B.E., Heller J.M., and Kang H.K. 2006. Fatal motor vehicle crashes among veterans of the 1991 Gulf War and exposure to munitions demolitions at Khamisiyah: a nested case-control study. *American Journal of Industrial Medicine,* 49:261-270.

86. Hooper T.I., DeBakey S.F., Lincoln A., Kang H.K., Cowan D.N., and Gackstetter G.D. 2005. Leveraging existing databases to study vehicle crashes in a combat occupational cohort: epidemiological methods. *American Journal of Industrial Medicine,* 48:118-127.

87. Kang H.K., Bullman T.A., Macfarlane G.J., and Gray G.C. 2002. Mortality among US and UK veterans of the Persian Gulf War: a review. *Occupational and Environmental Medicine,* 59:794-799.

88. Knapik J.J., Darakjy S., Marin R., Hoedebecke E.L., Mitchener T.A., Sharp M.A., Rivera Y., Grier T., Brown J., and Jones B.H. (2007). Injuries and physical fitness before and after an Afghanistan deployment of the 10th Mountain Division. Technical Report No. 12-MA-05SD-07, Aberdeen Proving Ground MD: US Army Center for Health Promotion and Preventive Medicine.

89. Knapik J.J., Rieger W., Palkoska F., VanCamp S., and Darakjy S. 2009. United States Army Physical Readiness Training: rationale and evaluation of the physical training doctrine *Journal of Strength and Conditioning Research,* In Press

90. Knapik J.J., Hauret K.G., Arnold S., Canham-Chervak M., Mansfield A.J., Hoedebecke E.L., and McMillian D. 2003. Injury and fitness outcomes during implementation of Physical Readiness Training. *International Journal of Sports Medicine,* 24:372-381.

91. Knapik J.J., Darakjy S., Scott S.J., Hauret K.G., Canada S., Marin R., Rieger W., and Jones B.H. 2005. Evaluation of a standardized physical training program for Basic Combat Training. *Journal of Strength and Conditioning Research,* 19:246-253.

92. Knapik J.J., Bullock S.H., Canada S., Toney E., Wells J.D., Hoedebecke E., and Jones B.H. 2004. Influence of an injury reduction program on injury and fitness outcomes among soldiers. *Injury Prevention,* 10:37-42.

93. Knardahl S. 2005. Psychological and social factors at work: contributions to musculoskeletal disorders and disabilities. *Giornale Italiano di Medicina del Lavoro ed Ergonomia,* 27:65-73.

94. Vileikyte L. 2007. Stress and wound healing. *Clinical Dermatology,* 25:49-55.

95. Nippert A.H., and Smith A.M. 2008. Psychological stress related to injury and impact on sports performance. *Physical Medicine and Rehabilitation Clinics of North America,* 19:399-418.

96. Gupta M.A., Lanius R.A., and VanderKolk B.A. 2005. Psychological trauma, posttraumatic stress disorder and dermatology. *Dermatologic Clinics,* 23:649-656.

97. Hardy L. 1992. Psychological stress, performance, and injury in sports. *British Medical Bulletin,* 48:615-629.

98. Schaffer M., and Barbul A. 1998. Lymphocyte function in wound healing and following injury. *British Journal of Surgery,* 85:444-460.

99. Barbul A., and Regan M.C. 1995. Immune involvement in wound healing. *Otolaryngologic Clinics of North America,* 28:955-968.

100. DiPietro L.A. 1995. Wound healing: the role of macrophages and other immune cells. *Shock,* 4:233-240.

101. Park J.E., and Barbul A. 2004. Understanding the role of immune regulation in wound healing. *American Journal of Surgery,* 187 (Suppl 1):11S-16S.

102. Knapik J.J., Darakjy S., Jones S.B., Marin R.E., Hoedebecke E.L., Mitchener T.A., Rivera Y., Sharp M.A., Grier T., Brown J., and Jones B.H. 2007. Injuries and physical fitness before and after a deployment by the 10th Mountain Division to Afghanistan for Operation Enduring Freedom. Technical Report No. 12-MA-05SD-07, Aberdeen Proving Ground MD: US Army Center for Health Promotion and Preventive Medicine.

103. Knowles S.B., Marshall S.W., Bowling J.M., Loomis D., Millikan R., Yang J., Weaver N.L., Kalsbeek W., and Miller F.O. 2006. A prospective study of injury incidence among North Carolina high school athletes. *American Journal of Epidemiology*, 29:1209-1221.

104. Rauh M.J., Koepsell T.D., Rivara F.P., Margherita A.J., and Rice S.G. 2006. Epidemiology of musculoskeletal injuries among high school cross-country runners. *American Journal of Epidemiology,* 163:151-159.

105. Macera C.A., Pate R.R., Powell K.E., Jackson K.L., Kendrick J.S., and Craven T.E. 1989. Predicting lower-extremity injuries among habitual runners. *Archives of Internal Medicine,* 49:2565-2568.

106. Walters S.D., Hart L.E., McIntosh J.M., and Sutton J.R. 1989. The Ontario cohort study of running-related injuries. *Archives of Internal Medicine,* 149:2561-2564.

107. Marti B., Vader J.P., Minder C.E., and Abelin T. 1988. On the epidemiology of running injuries. The 1984 Bern Grand-Prix study. *American Journal of Sports Medicine,* 16:285-294.

108. Forde M.S., Punnett L., and Wegman D.H. 2005. Prevalence of musculoskeletal symptoms in union ironworkers. *Journal of Occupational and Environmental Hygiene,* 2:203-212.

109. Schneider G.A., Bigelow C., and Amoroso P.J. 2000. Evaluating risk of re-injury among 1,214 Army Airborne soldiers using a stratified survival model. *American Journal of Preventive Medicine,* 18(Suppl3):156-163.

110. Knapik J.J., Jones S.B., Ohlin D.W., Canham-Chervak M., Darakjy S.S., Goddard D.E., Hauret K.G., Hadley J.A., Twombley G., Harkins D.K., Bullock S.H., Drum J., Canada S.E., Mitchner T.A., Nevin R.L., and Jones B.H. 2006. Injuries and injury prevention in the US Army Band. Technical Report No. 12-MA-01Q2A, Aberdeen Proving Ground MD: US Army Center for Health Promotion and Preventive Medicine.

111. Sharp M., Knapik J.J., Walker L.M., Burrell L., Darakjy S., Lester M., and Marin R.E. 2008. Changes in physical fitness and body composition following 9 months deployment to Afghanistan. *Medicine and Science in Sports and Exercise,* 40:1687-1692.

112. Sharp D.S., Wright J.E., Vogel J.A., Patton J.F., Daniels W.L., Knapik J.J., and Kowal D.M. 1980. Screening for physical capacity in the U.S. Army: an analysis of measures predictive of strength and stamina. Technical Report No. T8/80, Natick MA: U.S. Army Research Institute of Environmental Medicine.

113. Knapik J.J. 1989. The Army Physical Fitness Test (APFT): a review of the literature. *Military Medicine,* 154:326-329.

114. Lester M.E., Knapik J.J., Catrambone D., Antczak A., Sharp M.A., Burrell L., and Darakjy S. 2009. Effect of a 13-month deployment to Iraq on physical fitness and body composition. *Medicine and Science in Sports and Exercise.* Submitted for Publication.

APPENDIX B
LETTER REQUESTING PROJECT

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G-3/5/7
450 ARMY PENTAGON
WASHINGTON, DC 20310-0450

REPLY TO
ATTENTION OF
DAMO-TR

MEMORANDUM FOR EXECUTIVE OFFICE OF THE SURGEON GENERAL
(DASG-ZXA), MS. SIL FINAMORE, 5109 LEESBURG
PIKE, ROOM 672, FALLS CHURCH, VA 22041

SUBJECT: Investigation of Elevated Post-Deployment Injury Rates

1. On August 29, 2006, I was briefed by the Office of the Under Secretary of Defense for Personnel and Readiness on data showing an increase in injury rates from pre- to post-deployment for units returning from Iraq and Afghanistan. The post-deployment injury rates were derived from diverse units from four installations (Fort Stewart, Fort Bragg, Fort Campbell and Fort Benning). The degree of increase in injury rates between pre- and post-deployment and the consistency among installations poses an immediate concern for Commanders and for the Army as a whole.

2. Request assistance from US Army Medical Command MEDCOM to assess and document whether such increases in injury rates occur consistently among units redeploying from the CENTCOM and what might be done to prevent such injuries. Specifically request the assistance of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) to investigate injury rates among soldiers in units that have recently redeployed from operations in Iraq and Afghanistan, including an assessment of the types, severity, patterns and causes of injuries pre- and post-deployment and recommendations on actions that can be taken to prevent such injuries.

3. Your assistance in expediting this is greatly appreciated. The results of such a preventive medicine investigation will help to determine the magnitude and nature of the post-deployment injury problem and assist in reducing the biggest health threat to unit and Army Readiness. My POC for this request is Dr. Joseph Knapik, 410-436-1328.

JAMES B. GUNLICKS
Senior Executive Service
Deputy Director of Training
HQDA, G-3/5/7